Kansas Water Resources Research Institute
Annual Technical Report
FY 2014

Introduction

The Kansas Water Resources Institute (KWRI) is part of a national network of water resources research institutes in every state and territory of the U.S. established by law in the Water Resources Research Act of 1964. The network is funded by a combination of federal funds through the U.S. Department of the Interior/Geological Survey (USGS) and non-federal funds from state and other sources.

KWRI is administered by the Kansas Center for Agricultural Resources and the Environment (KCARE) at Kansas State University. An Administrative Council comprised of representatives from participating higher education or research institutions, state agencies, and federal agencies assists in policy making.

The mission of KWRI is to: 1) develop and support research on high priority water resource problems and objectives, as identified through the state water planning process; 2) facilitate effective communications among water resource professionals; and 3) foster the dissemination and application of research results.

We work towards this mission by: 1) providing and facilitating a communications network among professionals working on water resources research and education, through electronic means, newsletters, and conferences; and 2) supporting research and dissemination of results on high priority topics, as identified by the Kansas State Water Plan, through a competitive grants program.

Research Program Introduction

Our mission is partially accomplished through our competitive research program. We encourage the following through the research that we support: interdisciplinary approaches; interagency collaboration; scientific innovation; support of students and new young scientists; cost-effectiveness; relevance to present and future water resource issues/problems as identified by the State Water Plan; and dissemination and interpretation of results to appropriate audiences.

In implementing our research program, KWRI desires to: 1) be proactive rather that reactive in addressing water resource problems of the state; 2) involve the many water resources stakeholders in identifying and prioritizing the water resource research needs of the state; 3) foster collaboration among state agencies, federal agencies, and institutions of higher education in the state on water resource issues; 4) leverage additional financial support from state, private, and other federal sources; and 5) be recognized in Kansas as a major institution to go to for water resources research.

Sediment Baseline Assessment

Basic Information

Title:	Sediment Baseline Assessment
Project Number:	2009KS71B
Start Date:	3/1/2010
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	2nd
Research Category:	Climate and Hydrologic Processes
Focus Category:	Sediments, Water Quality, None
Descriptors:	
Principal Investigators:	Dan Devlin, Will Boyer, Brock Emmert, Bruce McEnroe, DeAnn Presley, C. Bryan Young

Publications

There are no publications.

Title: Effects of Long-Term Management on Surface Soil Properties of Upland Soils in Northeast Kansas

Research Category: Land Use and Management

Focus Category: Agriculture (AG), Conservation (COV), Geomorphological Processes (GEOMOR), Management and Planning (M&P)

Primary PI: DeAnn Presley, Kansas State University (KSU) Department of Agronomy, 2014 Throckmorton, Manhattan, KS, deann@ksu.edu, (785)-532-1218.

Other PIs: Former graduate student, Ian Kenney.

Executive Summary

Sedimentation of lakes and reservoirs in Kansas is due to a combination of historic land use as well as erosion of streambeds and streambanks. This paper contributes to the present-day understanding of post-settlement land use and management effects on soils. The most stable upland landscape was selected for comparison between cropland and pasture. Transects were not randomly selected, but rather, were targeted in order to keep as many factors constant, with land use as the variable. In general, croplands were more eroded and lower in soil organic carbon (SOC), and had lower infiltration rates than pastures. Pastures generally had lower Mehlich III soil test phosphorus (P) levels than did croplands. While many producers in northeast Kansas have switched to no-till practices on cropland, the usage of additional practices that increase SOC would likely increase infiltration rates and reduce the risk of erosion and runoff.

INTRODUCTION AND LITERATURE REVIEW

Mollisols are defined by the presence of a mollic epipedon, the criteria for which are explained in Soil Taxonomy (Soil Survey Staff, 1999). In lay terms, mollisols are the thick, dark, organic matter-rich soils common to those formed under prairie vegetation, and now commonly cropped or managed as pastures. The thickness of the mollic epipedon can be (and often is) altered by erosion and by organic matter decomposition, both of which are exacerbated by tillage. Since the 1930's erosion phases have been mapped in soil surveys (Olson et al., 2005a), which means that the mappers fully realized that the soils they were observing had been altered by erosion, and thought that this was an important to document. According to Olson et al. (2005a), as of 1991, there were 20 million acres of eroded Mollisols mapped in the USA, mostly in the Midwest and Great Plains states.

The effects of management practices (tillage, fertilization, residue removal, crop rotation, etc.) are well understood and were recently summarized by Hatfield and Sauer, 2011. However, the effects on a given soil are a function of its inherent soil properties and thus, the results and degree to which they are expressed is a product of the inherent properties and management practices. Land use is dynamic. For example, for a given field in northeastern Kansas, it was grassland for thousands of years until the area was settled in the 1840's to 1860's. The best agricultural land was either plowed for crops, or grazed by livestock. Starting in the 1950's, programs for reducing agricultural production and conserving soil resources would place many acres back into grassland, or for cropland, the use of terraces and other structures. Conventional tillage was predominant until reduced and conservation tillage began in the 1970's, increasing to ≈70% no-till practices today in northeast Kansas (Presley, 2011). Today, the landscape of northeastern Kansas represents a patchwork quilt of land uses, and thus, presents an excellent opportunity to sample soil series under multiple land uses and compare today's soil descriptions with historical descriptions contained in soil surveys completed between ≈1950 and ≈1970.

Veenstra (2010) examined 82 representative soil profiles from 21 counties in Iowa that were originally sampled and described between 1943 and 1963 by the USDA. She found that after 50 years of agricultural land use many (60%) were different from their original descriptions, and that changes in the thickness of the mollic epipedons caused about half of the changes in classifications observed in the U.S. system of taxonomy. Veenstra studied soils across the landscape, and while some soils lost mollic epipedon thickness, other soils (footslopes especially) gained. Kimble et al. (1999) studied soils on eroding landscape positions only, thus observed higher levels of soil loss and greater reductions of mollic epipedon thickness. Thirty-two percent of the sites were no longer Mollisols and 27 to 71% of the mollic epipedon had been lost. Amundson et al. (2003) observed that much of the central U.S. has a very high proportion of endangered soil series, due to the impact of erosion on mollic epipedons.

The goal of this project was to examine the effects of land use and management on Mollisols of northeast Kansas, with a focus on upland soils in watersheds above the Atchison, Banner Creek, and Centralia lakes. The objective is to characterize the influence of land use (cropland versus grassland) on the morphology, mollic epipedon thickness, organic C content, and infiltration rate.

SITE LOCATIONS AND METHODS

The study sites are located on narrow upland summits of the Pawnee clay loam soil series (fine, smectitic, mesic Oxyaquic Vertic Argiudolls) (Soil Survey Staff[a]). The mapunit that was selected was the Pawnee clay loam, 1 to 3% slopes. This soil type is frequently cropped, but there are many pastures interspersed in the study watersheds. Our goal was to perform transect perpendicular to the slope and between a cropped field and a pasture. Each transect was composed of multiple stops in order to gain an understanding of the average soil properties for each field. Two complete cropland/pasture transects were completed for Atchison, and four transects were completed in each of the Banner and Centralia watersheds (Figure 1). All sites were on privately owned land and permission was secured from the landowners prior to sampling.

Soil pedons were investigated using a hydraulic, truck-mounted soil probe. Pedons were sampled to the depth of refusal, usually by large rocks common in the glacial till parent material. All pedons were described using the Field Book for Describing and Sampling Soils (Schoeneberger et al., 2002). Samples were split by genetic horizon, air-dried, sieved to 4 mm, removed of visible organic materials, ground with mortar and pestle, and sieved to 0.25 mm for measurement of total C by dry combustion with a LECO TruSpecCN analyzer (LECO Corp., St. Joseph, MI) (Nelson and Sommers, 1996). Bulk density was determined for each horizon (from a second soil profile) by the core method (Blake and Hartge, 1986). The percentage of C was multiplied against bulk density to compute total soil C pool in Mg ha^{-1}. Soil samples were submitted to the Kansas State University Agronomy Soil Testing Lab for the measurement of Mehlich-3 phosphorus.

A network of automated mini-disk infiltrometers (Madsen and Chandler, 2007) provided 24 in-situ measurements per site of near-saturated (K_{-2cm}) infiltration (Figure 2). The networks were deployed around two pedons per pair (one for each land use)

RESULTS AND DISCUSSION

Data from the soil profile descriptions are presented in Table 1. A calculation was performed to determine how different the mollic epipedon thickness was relative to the pasture. This is referred to as the percent (%) eroded, although any loss of C in the soil is recognized to result from both erosion and accelerated soil organic matter decomposition from tillage. The cropland sites of the Atchison and Centralia watersheds were on average 63 and 38% eroded, respectively. The Banner watershed sites were different in that for two of the transects (2 and 3) the cropland sites had a thicker mollic epipedon than the pasture. This could be explained in one of two ways: It is possible that the pasture site had been significantly degraded prior to being replanted to permanent vegetation, or that it is currently experiencing erosion from a process such as overgrazing. The alternative is that the cropland sites within these transects are less eroded than expected, or that the landowners have been exceptionally good stewards and employing soil management practices that sequester soil organic matter. When averaged across all four transects, the Banner watershed site is 18% eroded, but if you ignore the two sites that were 0% eroded, this value would be 35%, which is more similar to the values observed in the Centralia watershed.

Surface hydraulic conductivity rates (K) measured with tension (-2 cm) infiltrometers (Table 2) ranged between 3 and 11 µm sec^{-1}, which is within the typical range (1 to 10 µm sec^{-1}) expected for low bulk density soils (Figure 3). The USDA-NRCS hydraulic conductivity value reported for the Pawnee clay loam, 1-3% slopes (mapunit 7500) is 3 um sec^{-1} (Soil Survey Staff[b]). The values for the pastures in Atchison County and Banner Creek watersheds are more rapid than the cropland K. This allows for greater water movement into the soil profile after a precipitation event, and thus, can lead to less runoff. For the Centralia site the values were similar, and were overall the lowest of the study.

The mass of SOC for the mollic epipedons are reported in Table 2. The Atchison site, despite being the most eroded of the three (Table 1) contained the most SOC because of high SOC concentrations (values not shown), which is puzzling. Due to the small number of transects sampled in this watershed (two), we will avoid drawing conclusions from this data. The SOC of both the Banner and Centralia watersheds were greater for the pasture, particularly so for the Centralia site. Interestingly, despite the greater SOC mass for Centralia pastures, this did not lead to greater K values in the Centralia watershed.

The Mehlich III Extractable P values were greater for the cropland transects in both Banner and Centralia by a large margin, while in the Atchison watershed is was similar (≈ 7 ppm). The Atchison values are within the “very low” range for Kansas (Figure 4, from Leikam et al. 2003). The pasture values for Banner and Centralia are also in the “very low” range. The Centralia cropland sites are very near the 20 ppm value, below which the Kansas State University Soil Testing Laboratory recommends that producers add P fertilizer to attain maximum yields. The Banner cropland values are in the high range.

CONCLUSIONS

This study would benefit from some expansion in the number of transects sampled, yet some trends are apparent. First, it is interesting to note that the watersheds have some different characteristics. Atchison was in some ways had the most unexpected results; the cropland was the most eroded in this watershed, yet the SOC values were much higher than the other sites, and the cropland P values were very low. Since there were only two transects sampled we will view the results for this site with caution. The Banner Creek site was predictable in that the infiltration rate and SOC was higher for pastures, while the P values were higher for cropland. The confounding issue with this site is that two of the transects had just as much if not more topsoil thickness than the pastures. The Centralia site results were a bit more straightforward as the cropland was overall 38% eroded relative to the pasture and the infiltration rate and SOC were lower for the cropland and the P value was higher for cropland.

Overall, these results are an indication that soils are dynamic and that management has impacts on the properties of the surface soil that are a culmination of many years of management. Since soil data is often used as a basic input layer into geographic information system models, etc., it is important that we continually update the soil resource database so that modelers and other types of predictive tools have the best, most up-to-date data for their efforts

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Table 1. Summary of mollic epipedon thickness (cm) by watershed. The mollic epipedon is roughly equivalent to what is referred to as topsoil, in that it has high organic matter and dark colors. The % eroded means how eroded the cropland is compared to the pasture condition.

Watershed	Transect	Cropland	Pasture	% eroded	Average
Atchison	1	19	48.3	61	
	2	14.5	41.5	65	63
Banner	1	26.5	42.8	38	
	2	39.3	38.3	0	
	3	33.3	29	0	
	4	16.5	24.3	32	18*
Centralia	1	26	41.3	37	
	2	34.3	41.6	18	
	3	17.3	40.3	57	
	4	19.7	33.6	41	38

*If the two Banner watershed transects with zero % eroded values are ignored, the average % erosion for Banner is 35%.

Table 2. Surface hydraulic conductivity rates (K) measured with tension infiltrometers (-2 cm). The values reported are averages. The USDA-NRCS hydraulic conductivity value reported for the Pawnee clay loam, 1-3% slopes (mapunit 7500) is 3 um sec^{-1}. Therefore, these results do not differ greatly from the measured values, however, the values for the pastures in Atchison County and Banner Creek watersheds are more rapid than predicted. This allows for greater water movement into the soil profile after a precipitation event, and thus, can lead to less runoff.

		K (-2 cm)	SOC	Mehlich III Extractable P
		µm sec^{-1}	Mg ha^{-1}	ppm
Atchison	Crop	5.17	118.4	7.0
	Pasture	10.21	104.3	7.4
Banner	Crop	5.31	47.0	36.6
	Pasture	7.81	55.4	9.3
Centralia	Crop	3.99	51.1	19.3
	Pasture	3.38	91.3	1.6

Figure 1. Transect sampling method. The smaller figure shows the locations of the four transects completed for the Centralia Lake watershed, and the smaller figure illustrates the layout of a typical transect between a cropland field and adjacent pasture. The entire transect occurs on one soil type and attempts to minimize difference in slope.

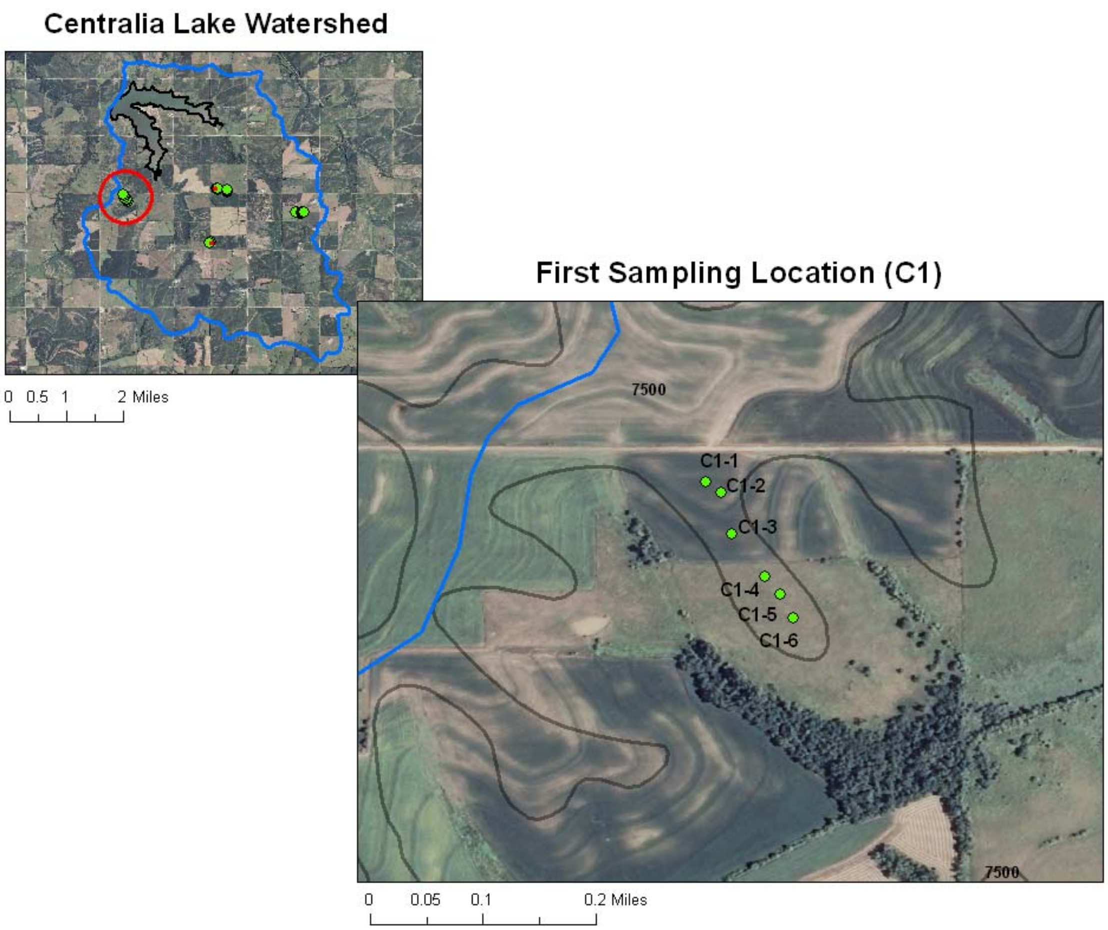


Figure 2. Soil sampling was completed by coring with a hydraulic truck-mounted soil probe, and infiltration measurements were collected using an automated mini disk infiltration network.

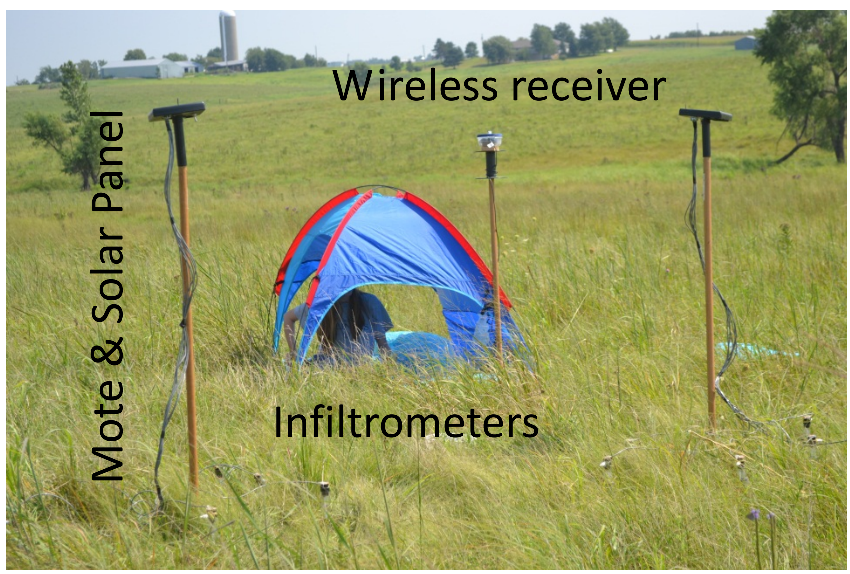


Figure 3. Typical ranges in saturated hydraulic conductivity (Ksat) for soils. The values recorded in this study are within the expected ranges. Source for the diagram: http://soils.usda.gov/technical/handbook/contents/part618ex.html

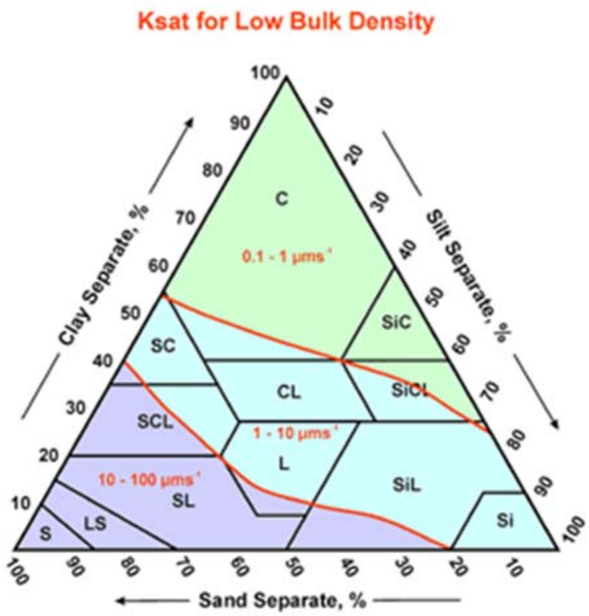
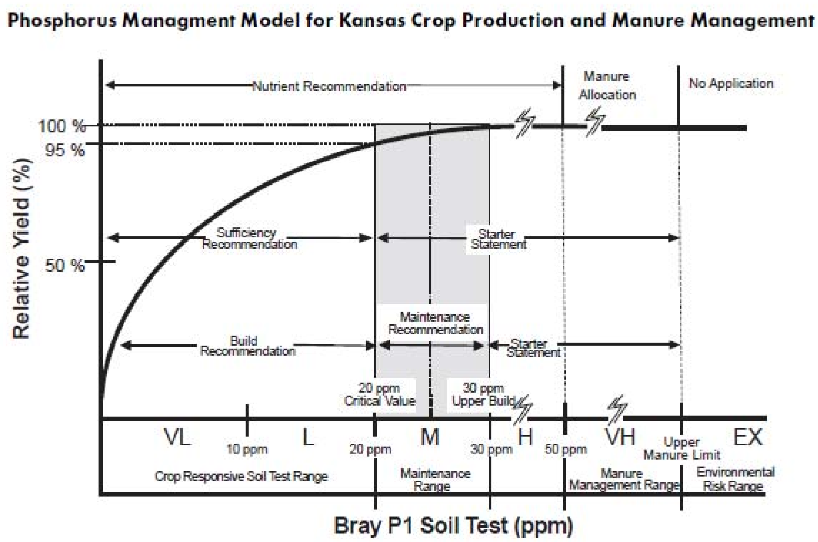


Figure 4. Phosphorus management recommendations for Kansas (Leikam et al., 2003).



Presentation given during the reporting period:

Presley, DeAnn., Kenney, Ian. April 14, 2014. Effects of Long-Term Management on Surface Soil Properties of Upland Soils in Northeast Kansas. Sedimentation Research Workshop: Understanding the Sedimentation of Kansas Lakes.

Publications during the reporting period:

A manuscript based on the findings of this research project is in the initial stages of preparation.

Impacts of In-channel Dredging on the Morphology of the Kansas River

Basic Information

Title:	Impacts of In-channel Dredging on the Morphology of the Kansas River
Project Number:	2012KS125B
Start Date:	3/1/2012
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-002
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Sediments, None
Descriptors:	None
Principal Investigators:	Melinda Dawn Daniels

Publication

1. Mehl*, H.E., M. Daniels, B. Swenson*, and L. Calwell. 2012. Commercial sand dredging in the Kansas River. Presented at the Governor s Conference on Water and the Future of Kansas; Manhattan, KS, 31 Oct.

Impacts of In-Channel Dredging on the Morphology of the Kansas River

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In year one of the project we have surveyed two active dredge holes in the Kansas River, one in Topeka and one in Lawrence. A third (also near Lawrence and the Mudd Creek confluence) has been targeted for survey, but low water has prevented access to the site even with small boats (kayaks). The Topeka and Lawrence dredge holes were surveyed using an ADCP (Acoustic Doppler Current Profiler) on two occasions, once in Fall of 2012 and once in Spring of 2013. During this time period, no significant transport active flow occurred on the Kansas River. Our repeat surveys show substantial deepening and enlargement of each dredge hole due to continued excavation and no/insufficient transport-related replacement or infilling by the river. We remain ready to re-sample with the ADCP when flow rises on the Kansas.

While we wait for flow to rise on the Kansas, the GRA has been assembling a HEC-RAS model of the Kansas River main stem and major tributary network architecture.

Water Research for the Fort Riley Net Zero Initiative

Basic Information

Title:	Water Research for the Fort Riley Net Zero Initiative
Project Number:	2013KS178S
USGS Grant Number:	G14AP00004
Sponsoring Agency:	EPA_Kstate
Start Date:	11/25/2013
End Date:	11/24/2014
Funding Source:	104B
Congressional District:	1st
Research Category:	Not Applicable
Focus Category:	Water Quality, Water Quantity, None
Descriptors:	NET Zero Water, water conservation, water reuse, water mining, water treatment
Principal Investigators:	Stacy Lewis Hutchinson, Gerad Middendorf, Natalie Mladenov

Publication

1. Middendorf, Gerad; Terrie Becerra, 2014, Fort Riley Net Zero Water, Kansas State University, Manhattan, Kansas, 34 pages.

Summary of work to date:

Kansas State University is working with Fort Riley personnel, EPA ORD, and EPA Region 7 to develop strategies for meeting the Department of Defense Net Zero Water goals. Specific project objectives for the Fort Riley demonstrations are:

1. Investigation of methods for safe reuse of waste water through the decentralized treatment of water from sewer lines (Titled: Decentralized Waste Water Treatment Technology Demonstration);
2. Containment, control and disposal of large volumes of wastewater following an event involving biological agents (Titled: Wastewater Security Investigation);
3. Use of engagement, education, motivation, and empowerment to reduce water demand at Ft. Riley, with a measurement of the effectiveness of each (Titled: Demand Side Outreach and Intervention Study).

Research was initiated in January 2014 and work is ongoing for the wastewater reuse and water security project. The Demand Side Outreach and Intervention Study was completed in December 2014 (see attached report).

Specific Project work:

1. Decentralized Waste Water Treatment Technology Demonstration – supporting one MS student on this project. Continued to participate in monthly project meetings via telephone and attended several on-site meetings with EPA, Fort Riley, and contractors to discuss system function, operation and monitoring.

2. Wastewater Security Investigation – Supporting one MS student on this project. Continued to assess AOP trailer function and determine the impact of total suspended solids on the performance of the system. While there is solid performance of the system about 50% of the time, problems with the UV light source continue to plague tests and require maintenance. Additional maintenance was performed and more test to determine what was causing the inconsistency of performance. Residual chloramines were determined to impact system performance and studies are being re-worked to dechlorinate and/or use natural waters for testing.

3. Demand Side Outreach and Intervention – supported 50% of post-doctoral fellow. See attached final report.

Summary Report:
Fort Riley Net Zero Water Research Survey

December 2014

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EXECUTIVE SUMMARY

Past research has determined that water consumption within households is dependent on numerous factors that include both facts about the members of a household and the property itself. These factors include: the number, ages, and education levels of persons in the household, household income, the attitudes, beliefs, and behaviors regarding water consumption, the efficiency of water consuming devices (e.g., clothes washers, shower heads, tap fittings, dishwashers, toilets), and property lot size (Nieswaidomy and Molina, 1989; Renwick and Archibald, 1998; Mayer and DeOreo, 1999; Renwick and Green 2000; Inman and Jeffrey 2006). Although the cost of water was initially predicted to influence consumption, this belief has been dispelled through demonstrating that the price of residential water demand is inelastic because of its low cost relative to other essentials (Worthington and Hoffman 2008; Barrett, 2004). Water management initiatives often include pressure on residents to reduce household water consumption through undertaking more sustainable water consumption practices (Willis et al. 2011). Thus, for water demand management, consumers' attitudes, beliefs, and actual behaviors are the factors that are particularly relevant (Nancarrow et al. 1996; Hassell and Cary 2007). Shifting residents towards sustainable water consumption practices thus requires the instilling of awareness, understanding, and appreciation of the environment and water.

Identifying the baseline attitudes, awareness, and knowledge of water conservation and demand, as well as water conservation practices, is the first step towards developing targeted messages and educational materials to promote resource conservation. The approach for reducing water demand on Fort Riley is composed of two parts, one technical, and one behavioral. The behavioral component was addressed by gathering data from an online survey that asked respondents about attitudes they hold toward water issues, water conservation, current water use behaviors, water re-use, and demographic information. Resulting data were analyzed to identify baseline measures of water issue awareness, environmental attitudes, current water conserving behaviors, and attitudes toward water re-use. Respondents were also given the opportunity to comment on issues they believe are important.

Key Findings

Respondent Profile:

- In general, respondents were white (74%), male (68%), 36 years of age (modal age is 36, average age is 42), from Kansas (54%), college educated (77% had from some college to a bachelor's degree completed), and earning an average annual salary of $70,000 or more.

Respondents generally . . .

- Are quite aware of the need for water conservation.
- Are aware that the Army and Fort Riley have water use reduction goals.
- Believe it is important to save water when at the home station, during field training, and when deployed.
- Believe protecting our drinking water supply is very important.
- Believe their individual/household water use is average or below.
- Believe they are conscious of their water use and try to "conserve whenever possible."
- Report engaging in a variety of water conserving behaviors.

- Agree that water conservation programs like Net Zero are necessary.
- Believe "everyone should make an equal effort to conserve water wherever possible."
- Believe responsibility for protecting water resources belongs to individuals, local and state governments, private entities, and the federal government – in that order, with individuals bearing the most responsibility and the federal government the least.
- Feel that the Army's capabilities are best suited to cleaning and treating water for re-use at home stations.
- Are agreeable to re-using any type of wash water (e.g., hand, shower, laundry) for re-use in any type of washing.
- Are less comfortable about re-using treated water for drinking.

PROBLEM AND OBJECTIVES

The ability to manage water more efficiently necessitates engagement with the drivers of water demand, and an exploration of the interface between water use practices and water saving technology to promote a blanced, long-term approach to water conservation on Fort Riley. The over-arching objective of the larger Net Zero project is to initiate and sustain measurable reductions in water use for different groups of participants and to establish an accurate residential water use profile for the installation. Part of the solution to reducing water demand on Fort Riley is technical (e.g., through installation of technology to make water re-use possible) and part of the solution is behavioral (e.g., choosing to water landscaping during cooler periods of the day). The first step of this process is assessing baseline attitudes and knowledge of water conservation practices. Knowledge of existing attitudes, beliefs, and behaviors will facilitate development and implementation of targeted educational and communication efforts for achieving behavior change.

This study's primary objectives were to gauge:

1) Awareness, attitudes, and beliefs regarding
    a. water conservation in general,
    b. water conservation on Fort Riley, and
    c. water consumption at the household level
2) Current water use behaviors, including
    a. motivations and constraints to conservation, and
    b. conserving behaviors
3) Environmental attitudes and environmental water issues
4) Attitudes toward water re-use

METHODS

An online questionnaire was developed and administered to all personnel – both military and civilian—who work on Fort Riley Army Post. Previous surveys regarding attitudes, perceptions, and awareness of environmental issues and water use were consulted in developing the questionnaire (e.g., Mabel 2012; Evans et al. 2011, and Theodori and Fox 2009). The questions focused on participants' awareness of water conservation issues, general environmental attitudes, household water use, Army water conservation and waste, motivations and constraints to water conservation, and water re-use, as well as general demographic information.

The survey was constructed, and initial analysis performed using Qualtrics survey software (Qualtrics, Provo, UT). The survey was pre-tested from July 7 to 23 with a small sub-sample of Fort Riley employees. Clarifications were made and the survey was subsequently administered to the entire post. The first message was delivered August 4-6, 2014. As follow-up, the message was resent on August 14, 15, and 27, 2014. Of the surveys delivered, 257 (28%) preferred not to respond; 644 (70%) willingly agreed to participate; 921 surveys were opened (the computer file was opened), and 618 surveys were completed (completion rates between 10% and 100%). Of the completed surveys, 489 attained 90% to 100% completion.

Through the cooperation of the Fort Riley Operations Center, Department of Emergency Services, a link to the online survey was delivered to all computers on Post via AtHoc messaging, the installation's mass notification system. This delivery approach is inclusive while also protecting the identity of participants.

FINDINGS

This section of the report presents findings of all respondents, addressing the study's primary objectives. Each section contains response percentages for survey questions related to the objective. Percentages are calculated on the actual number of participants responding to each question.

Respondent Profile

The typical respondent to the survey was a white male, 36 years (modal age is 36, average age is 42) of age from Kansas who is college educated and earning an average annual salary of $70,000 or more (Table 1).

Table 1. Demographic profile of survey respondents.

Home State	Kansas		54%
Gender[1]	Male		68%
	Female		27%
Race/Ethnicity[2]	White		74%
	African American/Black		10%
	Others		7%
Age	Average age		42
	Age most respondents reported		36
	Minimum age reported (n=3)		21
	Maximum age reported (n=4)		65
Education	High School graduate, includes equivalency		5%
	Some college		38%
	Bachelor's degree		39%
	Master's degree		13%
	Professional school degree		2%
	Doctorate degree		2%

Gross Household Income[3]	Less than $36,000 per year		4%
	$36,000 – $49,999		10%
	$50,000 – $69,999		19%
	$70,000 – $99,999		28%
	$100,000 – $130,000		17%
	$130,001 – $150,000		5%
	More than $150,000 per year		5%

[1] 5% preferred not to respond
[2] 15% preferred not to respond
[3] 12% preferred not to respond

Objective 1a: Awareness of water conservation

Nearly all respondents (98%) reported being aware of the importance of using less water generally. More than half of the respondents report gaining this awareness from media, as a child, when attending school, or from family. Less than half (43%) reported learning it from Army training (Tables 2a and 2b).

Table 2a. Awareness of the need for water conservation.

	Response	%Yes	%No
Have you ever heard about the importance of using less water?	617	98	2

Table 2b. Sources of water conservation information.

How did you hear about it? (Mark all that apply).	Response	%
Television	455	75
As a child	412	68
From school	358	59
From family	345	57
From Army training	263	43

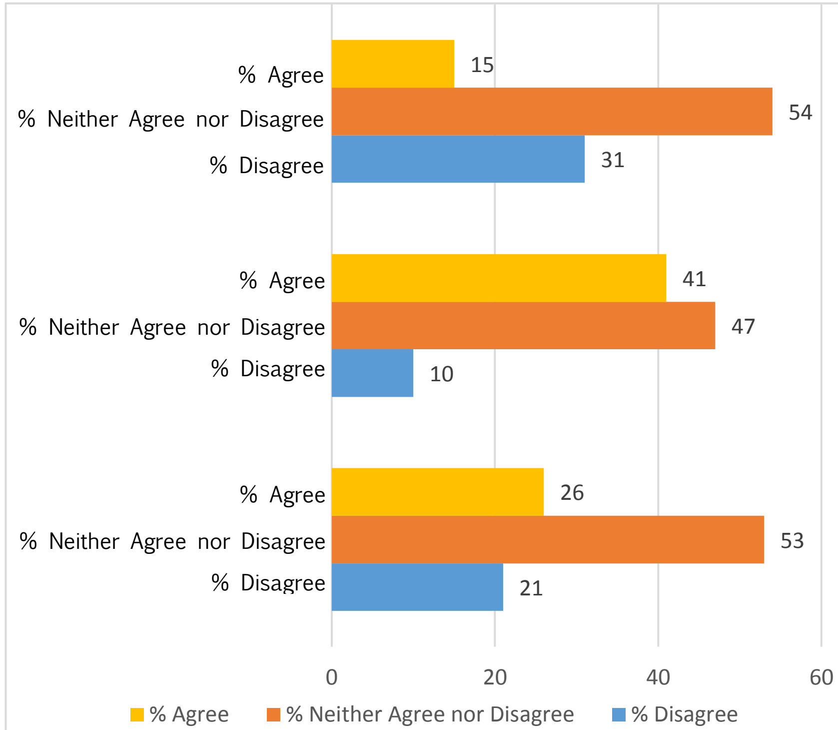
Most respondents (90%) agree that the need to conserve water is real, while 4% disagree that the need is real. However, 60% believe the likelihood of the region suffering from a prolonged drought is increasing, 38% believe it is staying the same, and 2% believe it is decreasing (Figure 1).

Figure 1. Perceived abililty of the Fort Riley region[1] to meet current and future water needs.

The Fort Riley region ***does not*** have enough water to meet the current or future needs of its citizens.

The Fort Riley region ***does have*** enough water to meet the current needs of its citizens, but it will be more difficult to meet future needs.

The Fort Riley region ***does have*** enough water to meet current and future (10 years from now) water needs of its citizens.



[1] The Fort Riley region is defined as an eight county area including Clay, Saline, Dickinson, Morris, Geary, Riley, Pottawatomie, and Wabaunsee counties.

Objective 1b: Water conservation concerning Fort Riley

Sizable majorities indicate awareness that both the Army and Fort Riley have water reduction goals (69% and 66% respectively). A large majority (88%) report that it is important to save water, and half or more have noticed water being wasted at their home station, during field training, and while deployed. Yet, only 30% report knowing how to report water waste (Tables 3a, 3b, 3c).

Table 3a. Awareness of Army and Fort Riley water reduction goals.

	Response	% Yes	% No
Are you aware that the Army has water use reduction goals?	617	69	31
Are you aware that Fort Riley has water use reduction goals?	612	66	34

Table 3b. Perceptions of the importance of saving water.

It is important to save water . . .	% Least Important	% Somewhat Important	% Moderately Important	% Important	% Very Important
When I'm at my home station.	2	3	7	29	59
During field training.	3	4	6	22	65
While I am deployed.	4	4	5	16	72

Table 3c. Recognizing and reporting water waste.

	Yes		No		
	Response	%	Response	%	Total
Have you ever noticed water being wasted . . .?					
At your home station?	386	68	185	32	571
During field training?	195	49	200	51	395
While deployed?	191	56	153	44	344
Do you know how to report water waste?					
At your home station?	162	29	422	71	594
During field training?	105	25	311	75	416
While deployed?	99	25	295	57	394

Objective 1c: Awareness of water consumption at the household level

A vast majority of respondents (91%) believe their household water use is average or below. Six percent reported usage as above average, and 7% reported not knowing (Figure 2). A majority of respondents is aware of water demands of various daily household activities (Figure 3).

Figure 2. Perception of household water use.

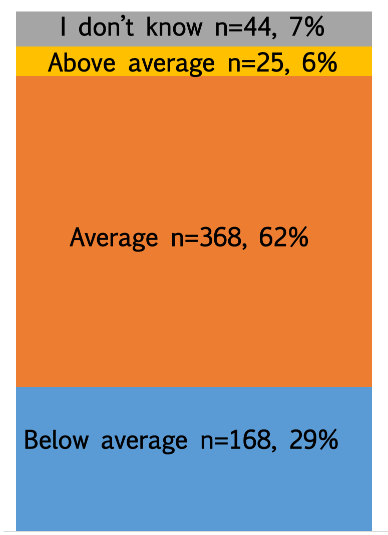
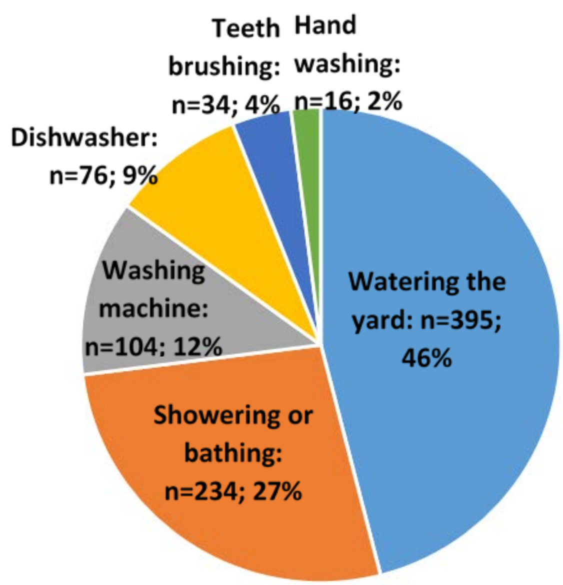


Figure 3. Which of these activities do you think uses the most water?



Objective 2a: Motivations and constraints to conservation

Respondents were asked to indicate the scenarios that would motivate them to conserve water. Choices included a set of scenarios that was economically oriented, and a set that was environmentally oriented. Responses were similar to both types of motivation scenarios (Table 4). For example, a substantial increase in the respondent's water bill (economic) would motivate them to conserve water (81%). Similarly, a severe drought (environmental) would also motivate them to converve water (87%).

Table 4. Scenarios that may ***motivate*** water conservation.

Economic Scenarios	Response	%	Environmental Scenarios	Response	%
Substantial increase in water bill	418	81	Severe drought	449	87
Reduced rates for reduced water use	354	68	Vanishing wildlife habitats	285	55
Free low-flow device(s)	270	52	Growing number of endangered species	220	42
Reduced agricultural yields	249	48	Pollution of freshwater	365	70
Mandatory regulations	271	52	Disappearing wetlands	261	50

Respondents were also asked to indicate the scenarios that would prevent them from conserving water. The scenario most reported as a constraint to conserving water was the belief that water was not being wasted by their household (69 %) (Table 5).

Table 5. Scenarios that would ***prevent*** water conservation.

	Response	%
I don't think my household is wasting water.	273	69
I don't know if household conservation efforts are effective.	95	24
I have the right to use any amount of water I choose.	65	16
Other (Please specify a reason)	48	12
Residential users do not use enough water to make a difference in water conservation efforts.	36	9
I don't know how to conserve water.	36	9

Objective 2b: Conserving behaviors

A large majority of respondents (88%) self-report awareness and making attempts to save water whenever possible. A majority of respondents report using water saving behavior for high water waste activities like teeth brushing, dishwashers, clothes washers, and water leaks. More than 20% of respondents report engaging in other water saving behaviors like redirecting downspouts, rainwater harvesting, and collecting cold water while waiting for hot water in the tap. The full list of respondents' behaviors to conserve water is reported in Table 6.

Table 6. Household Water Conserving Behaviors

	Response	%
Turn off the faucet while brushing your teeth or shaving	423	82%
Use dishwasher with only a full load	370	72%
Check for or repair water leaks around the house/barracks	348	67%
Lower the water level of the washing machine for smaller loads	301	58%
Take short showers (5 minutes or less)	284	55%
Wash dishes by hand	271	52%
Changed how often you water your yard	243	47%
Adopted low flow faucets or other water saving appliances	205	40%
Redirect downspouts towards lawn/ plants	137	26%
Changed the way your yard is landscaped	82	16%
Rainwater harvesting	84	16%
Collect cold water for other uses while waiting for water to heat up	64	12%

Objective 3: Environmental attitudes

Respondents were asked to rate themselves on an environmental-economic priority scale. The scale ranged from one to five. A value of one (1) indicated “total natural resource use,” which reflects an economic priority. A value of five (5) indicated “total environmental protection,” which reflects an environmental priority. A value of three (3) indicated an equal balance between use and protection. A small number of respondents rated themselves on the economic side of the scale (5%). About one-fourth (26%) rated themselves on the environmental side of the scale, while a majority (70%) rated themselves as placing their priorities for equal balance between use and protection.

All participants responded that protecting our drinking water supply is important (96% very important; 4% somewhat important). Regarding general environmental water issues, a majority of respondents responded that clean water (e.g., drinking water, groundwater, rivers and lakes, aquatic habitat, recreation) is important (Table 7).

Table 7. Importance of general environmental water issues.

	Not important		Somewhat important		Moderately Important		Very important		Total
How important are each of the following water issues to you?	Response	%	Response	%	Response	%	Response	%	
Clean drinking water	2	0	4	1	16	3	515	96	537
Clean groundwater—water in the ground that supplies wells.	3	1	6	1	40	7	489	90	537
Clean rivers and lakes	0	0	11	2	67	13	459	85	537
Clean water for aquatic habitat (fish, ducks, etc.)	3	1	13	2	85	16	437	81	537
Clean water for recreation	8	1	35	7	111	21	385	71	539

A majority of respondents (84%) agree that programs to reduce water consumption like "Net Zero" are necessary and agree "everyone should make an equal effort to conserve water wherever possible" (Table 8). In addition, a similar majority disagrees with the idea that people are "entitled to use as much water as they like" (81%). In Table 8, "These programs" refers to programs to reduce water consumption.

Table 8. Perceived importance of water conservation programs.

	Disagree*		Neither Agree nor Disagree		Agree**	
	Response	%	Response	%	Response	%
Every drop counts. Everyone should make an equal effort to conserve water wherever possible.	14	3	65	13	426	84
These programs are not necessary. People are entitled to use as much water as they like and we should trust them to make the right decisions.	227	81	104	14	169	7
These programs should focus only on ***excessive*** or ***careless*** water users.	397	45	70	21	498	34

*Percentages are the combined values of "Strongly Disagree" and "Disagree."
** Percentages are the combined values of "Agree" and "Strongly Agree."

Included among the environmental attitude questions were questions regarding who bears responsibility for protecting water resources. Respondents report a high degree of individual and local/state responsibility (Figure 4). Responsibility regarding military installations is presented in Figure 5, which also portrays a high degree of personal and local responsibility.

Figure 4. Respondents' beliefs regarding government responsibility for protecting water resources.

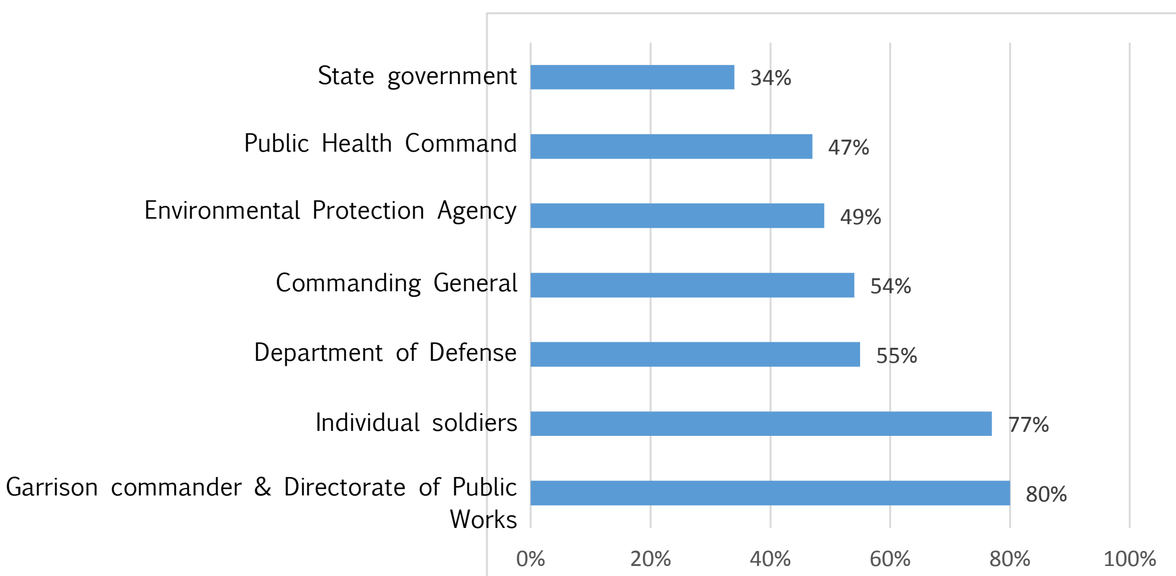
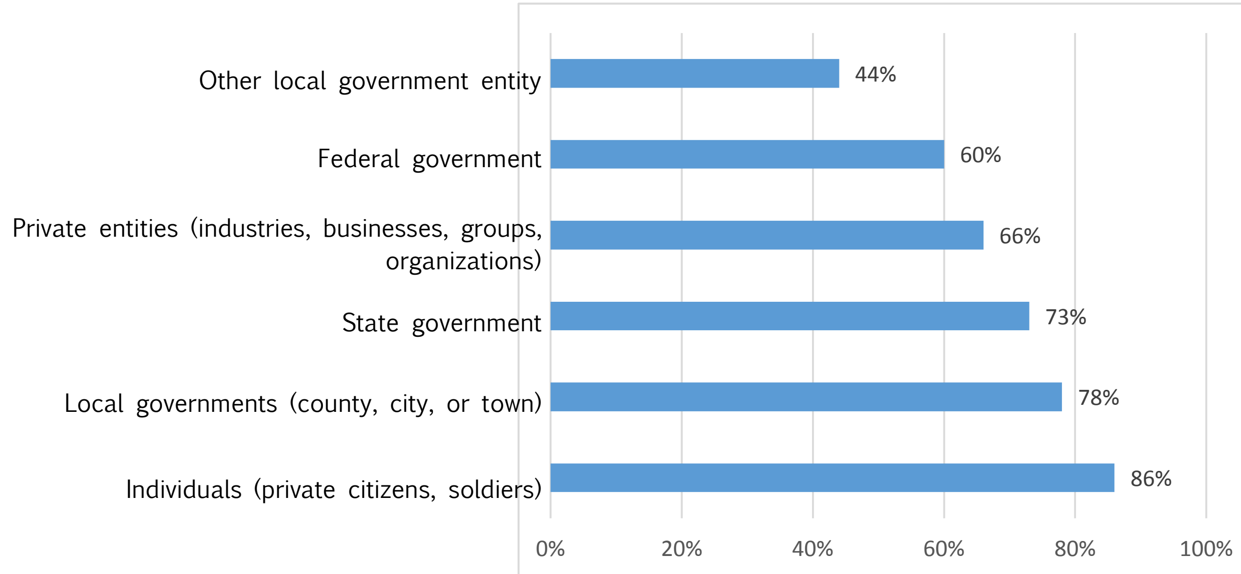
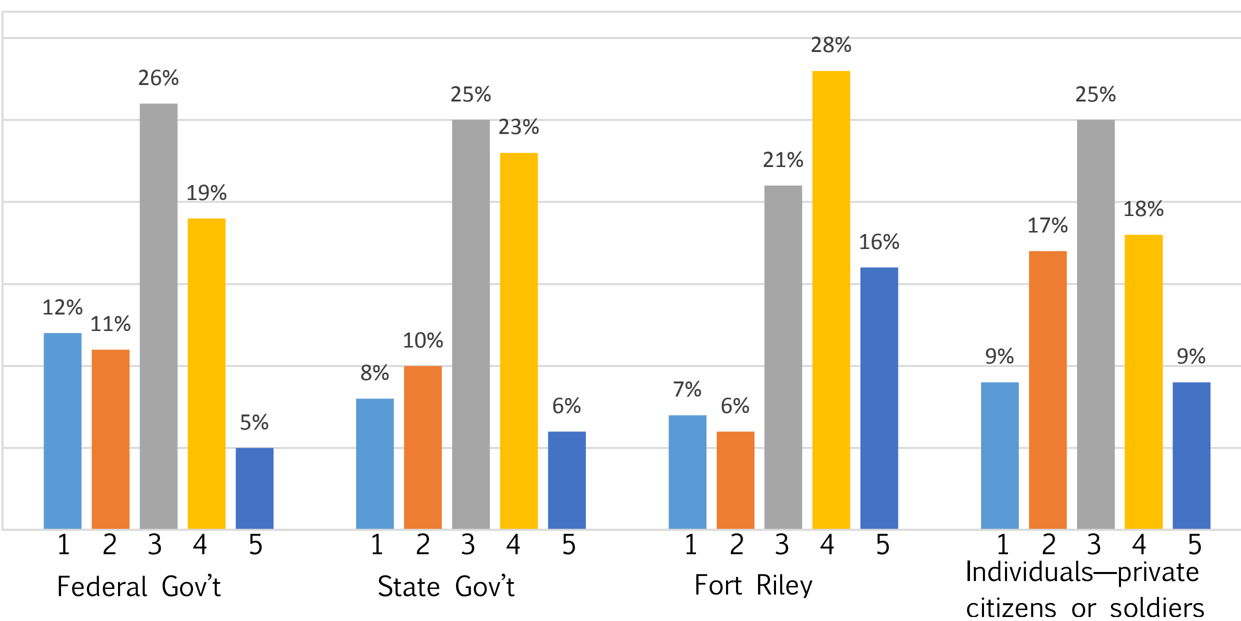


Figure 5. Respondents' beliefs regarding military responsibility for protecting water resources.



Respondents were asked to rate the effectiveness of the entities responsible for protecting water resources on Fort Riley (Figure 6). All entities were perceived by 50% or more respondents to be somewhat, moderately, or very effective and about 25% perceived them as ineffective. Notably, about 25% did not respond. Fort Riley was perceived to be more effective in its protection of water resources than either the state or federal government.

Figure 6. Effectiveness of Entities Responsible for Protecting Water Resources, n=492. Each entity was rated on a 5-point scale. Percentages for each entity do not total 100%; "no response" category is not shown. Scale: 1= very ineffective, 2=somewhat ineffective, 3=somewhat effective, 4=moderately effective, 5=very effective.



In addition to attitudes about water resources, respondents were asked about other environmental behaviors in which they engage as a way to more fully measure pro-environmental attitudes. The percent reported in Table 11 reflects pro-environmental attitudes through engagement in other environmentally friendly behavior, from energy saving behaviors, recycling and purchasing recycled products, to watching environmental awareness programming on television, and donating money to support environmental issues.

Table 11. Other resource conserving behaviors

	Response	%
Turn off lights when you leave a room.	482	97%
Recycle.	381	77%
Turn down the thermostat at night or when leaving for the day.	344	69%
Buy biodegradable or recyclable products.	291	58%
Avoid chemical use in your yard or garden.	254	52%
Reduce household trash by buying products that come with less packaging.	186	38%
Turn off air conditioning when leaving a room.	127	25%
Watch environmental shows on television.	80	16%
Donate money to environmental organizations to address water or other environmental issues.	58	12%

Objective 4: Water re-use

Most respondents believe the Army makes the health and well-being of soldiers, family members, and/or the civilian and contractor work force a top priority (Figure 7). About half of respondents believe the Army has adequate procedures in place to clean and treat water for re-use. However, about 20% believe this ability is greater at their home station than in training or when deployed (Figure 8). A majority (70-80%) report being comfortable with re-using captured water when it is re-used for the same purpose, e.g., water from hand washing that is captured, treated, and re-used for hand washing (Figure 9). However, less than half of respondents reported being comfortable with the idea of re-using captured water for drinking, about 40% reported being uncomfortable with the idea, and about 20% did not state their comfort level (Figure 10).

Figure 7. Percentages show agreement with statements that the Army makes health and well-being of soldiers, family members, and/or the civilian and contractor work force is a top priority of the Army under the three cirucumstances: 1)when at my home station, 2) during field traning, or 3)while I am deployed.

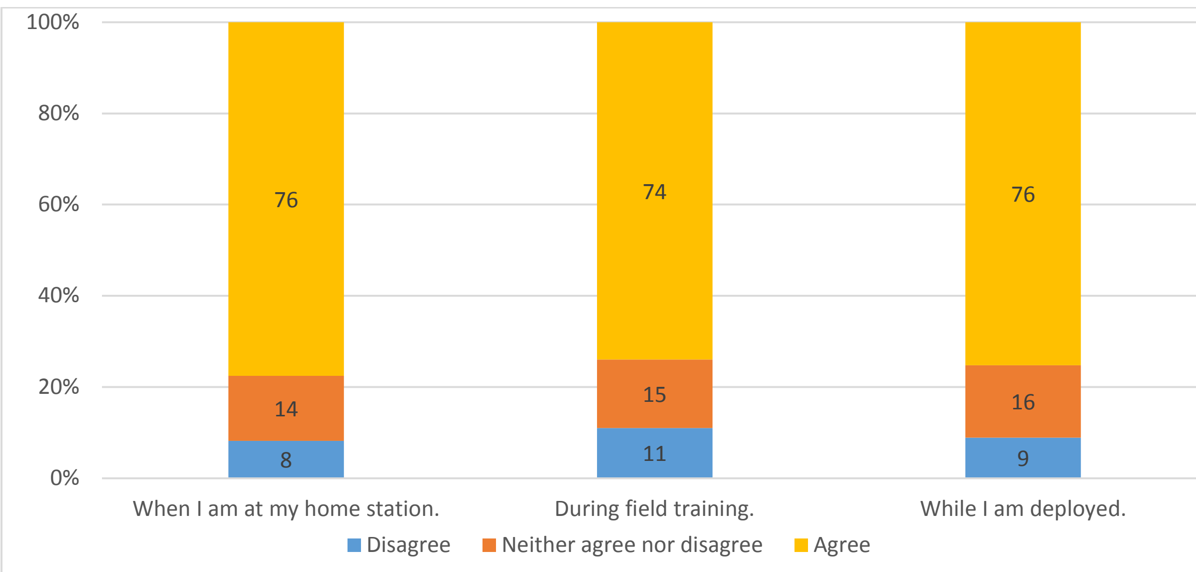


Figure 8. Percentage of agreement with the statement: “I am confident the Army has adequate procedures in place to clean and treat water for re-use .” Each circumstance was rated on a 5-point scale, bottom to top: strongly disagree, disagree, neither agree nor disagree, agree, strongly agree.

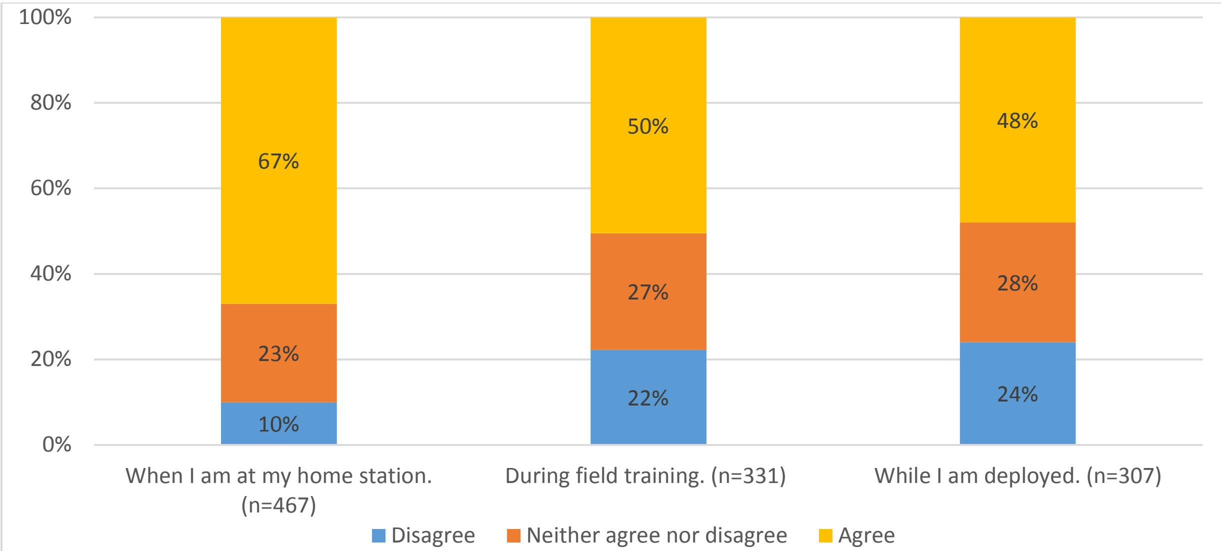


Figure 9. Percentage of agreement with the statement: “As long as it is properly cleaned and treated, I am comfortable re-using water captured . . . ” Each activity was rated on a 5-point scale: 1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree.

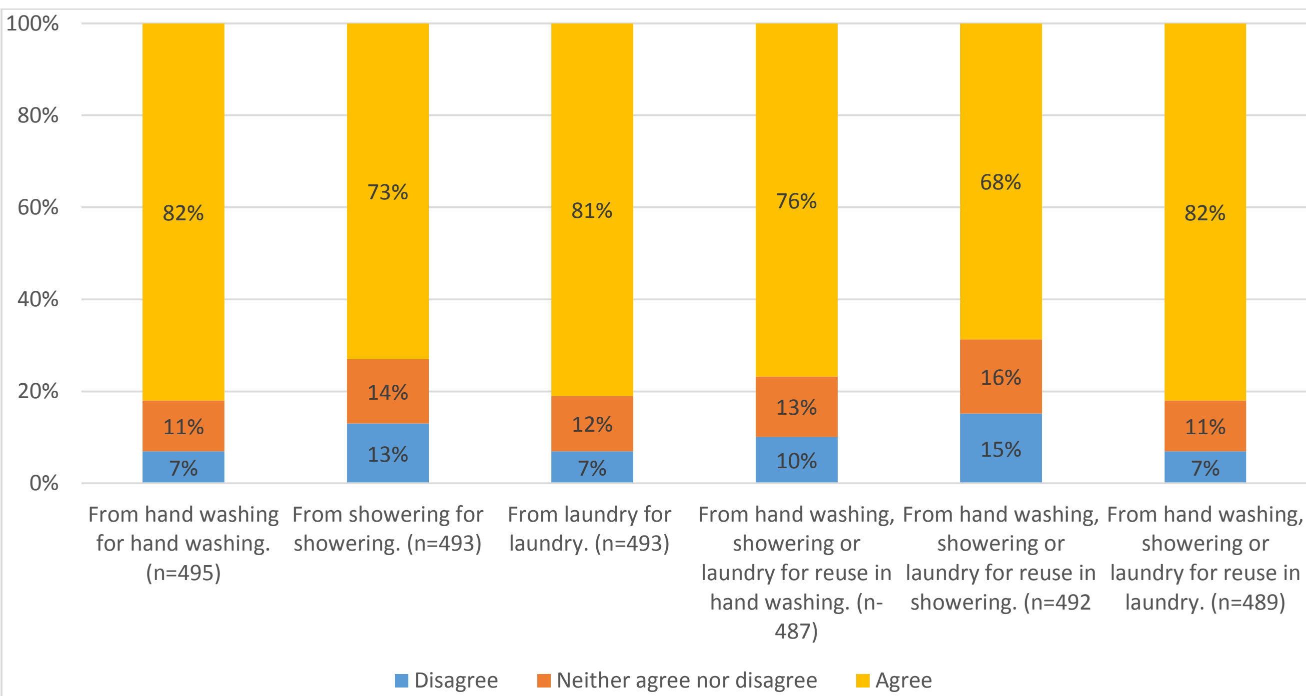
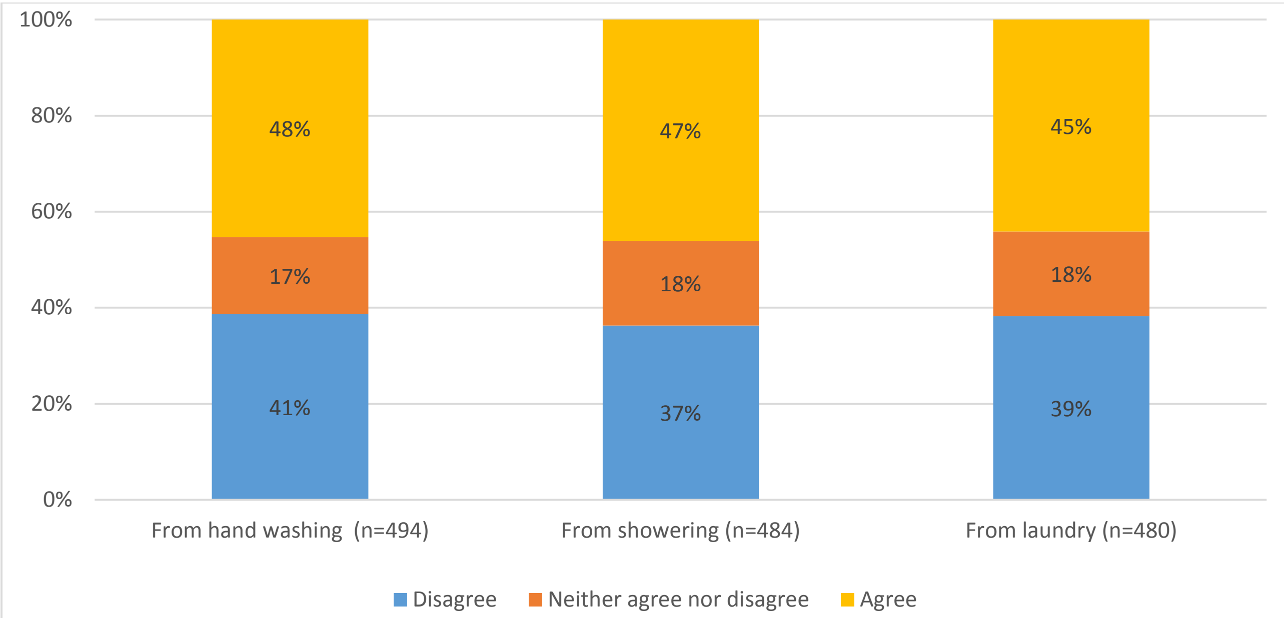


Figure 10. Percentage of agreement with the statement: “As long as it is properly cleaned and treated, I am comfortable re-using captured water for drinking water. . .”



Respondents Comments

A final section of the questionnaire provided respondents the space to write in any comments they so desired. There were 83 total responses to this section. Comments were coded into seven themes with multiple topics. Themes are: (Lack of) Awareness and/or knowledge, behavior, (water) quality, regulation, re-use, water as a resource, and waste. Although participants were instructed that they could make any comment they wished, comments tended to follow topics asked about in the questionnaire (Table 12).

Table 12. Salient comments corresponding respondent topics.

Topic and Salient Comments	Theme
Lack of awareness and/or knowledge	
Large numbers of people are realizing that clean potable water is growing scarce; however, there is little information, training or education/tools easily available on how to re-use/redirect used water (i.e. harvesting rainwater, laundry water). I believe that if schools provide, as part of the required agenda, environmental classes that focus on real world application that attitudes toward conservation would not seem inconvenient.	education
Education is the key to conservation. . . . As I drive on post, I see clearly that soldiers who live in the housing areas do not respect the water use. They wash their cars and let the water run down the street. Not having to pay for a water bill or any expense for energy to cool or heat teaches them to be wasteful. Living in	wastefulness

a housing area without limitations . . . does not make them aware of how expensive these commodities are. It’s my point of view, placing a restriction in housing, making the soldier accountable for usage and/or rewarding for conserving, will not only help the environment, that will also give them experience to conserve.	
Behavior	
Honestly, the people who waste water will continue to waste water, and the people who care about the water will not be able to change the wasters mind set. The ‘carers’ will continue to care and the ‘wasters’ will continue to waste.	apathy
We have a person in our office who likes to run the water for hours and when we tell him not to, he says he is actually helping by preserving the pipes and water flow systems by letting the water run. According to this worker, Fort Riley doesn't have to pay for their water and he is not wasting it, but rather helping by running the water.	Lack of knowledge
As the weather patterns begin to change and global temperature averages rise, water use, abuse, and conservation will be all the more important. When only 2% of the earth's water is readily attainable and harvestable fresh water, we cannot afford to waste or pollute our water sources.	climate change
I think water conservation education is key . . . My suggestion for Fort Riley is an aggressive public campaign that sheds light on the positive aspects of water conservation and includes incentives for those who participate. Making people realize that there is not an endless supply of clean water and that they can make several small changes in their water use that can help conserve water.	education & outreach; incentives
Water harvesting, low flow/zero flow urinals, toilets, and faucets, and even high efficiency appliances should not be an option. These things are just as user friendly and hygienic as the standard commercial product. . . . Restriction heads should be placed in all showers on the installation and whatever other means that could assist in saving water.	fixtures
I don't water my lawn often, I prefer having water to drink. … While a noble goal, unless water use in agriculture is addressed, Net Zero Water consumption will not be successful. Smart regulations like only watering landscaping at night; sensors to shut off sprinklers after adequate rainfall, and voluntary programs to reward reduced household water consumption would be a great start without inducing stress on families.	household conserving behavior
I also believe that each person in the community needs to be charged 20 to 40 dollars so they can begin fixing pipes that have been in place for 80 years or more. We need to have emergency water supplies for all the surrounding cities of Ft. Riley. This needs to happen before astronomical events happen and we have to pay a lot more!	incentives / disincentive; maintenance of infrastructure

People aren't going to change unless they are directly impacted. Water … should be a prepaid service. This way people will be involved in the process and learn, first hand, how much water they actually use on say a large load of laundry or a 7 min shower in addition to how much that shower or load costs. This could also give them a sense of control on the situation and make them feel like they are doing something about it.	Lack of knowledge; personal control
Quality	
Good to see others are concerned & working the issue....but what about the deliberate dumping of toxic fluoride & chlorine into the drinking water on Fort Riley? When will that be addressed?	Army practices
Most people do not know where their water comes from and do not care. A lot of people think that the treatments will take care of everything. I am originally from Toledo, OH where all of that was just proven wrong by the blue green algae toxins that were in the water supply - opened a lot of people's eyes.	Lack of knowledge
I never drink water on the installation. It has brown stuff in it. Sometimes I don't even like to use it to wash my hands . . .	Treatment
Regulation	
It appears to me that with all the additional regulations that are constantly being implemented with Federal and Stated EPA that all this is doing is causing people to fork out more money out of their paychecks for water and sewer charges. All we seem to read about is the increase in utility bill due to changes in regulations and the required upgrade in plants and infrastructure.	cost
I believe, sadly, that the only real way to make significant progress in saving and protecting water resources is strong incentives or strong disincentives.	enforcement
I do not think more regulations will conserve water or energy. I changed my behavior when I realized there is a need and we need to be good stewards with resources.	stewardship
I do not believe the State or Government should restrict US Citizen's water. Bottling companies should not be allowed to take public water and re-sale as bottled water in non- reusable containers.	water is a human right
Re-use	
When water is conserved in its use and reapplied back onto the land for recharge to aquifers, it is not lost or wasted. It is simply working its way through the hydrologic cycle. I am an avid golfer and am ashamed of our home course. It is my understanding that our course could be vastly improved if it could be watered and maintained using water that is currently being just disposed of because it is non-potable.	Gray water
Re-using water if it is cleaned properly is OK but I do not trust the government to clean it properly.	Health; social acceptability; trust

Resource

I believe that protecting our environment is important and it's not a bad idea to conserve our natural resources as much as possible, water being one of those. But I object to the usual methods of fear mongering and coercion that most "environmental" organizations use to try to guilt people to conform to their cause. When I see these types of behaviors being used, it generally tends to make me reject their efforts rather than try to help and or comply. Please don't use scare tactics when trying to get folks in the area to converse our resources. We all know there is plenty of water around, we just go through low periods from time to time. Mother Earth knows what she is doing and will make adjustments on her time scale, not man's.	Denial
Water shortage worldwide is critical. The only time people pay attention is when it's big headlines on their favorite media outlet. The problem is really too far gone to fix properly, but if we were properly educated starting about 30 years ago, we could still make a difference. Please cut out the politics and huge corporations that are covering this up and making billions from a resource that is too critical to waste even a moment fixing.	Gov't policy
Water is the most important element of nature right behind air. But to properly purify water it cost lots of money and when money is involved our government talks a good game but we will run out of water one day and we don't care because it doesn't affect us here and now.	Gov't policy

Waste

Even though there are programs in place, either they are not shared with workers, or the workers and their leadership do not care. I personally have to turn off a running sink about twice a day because the uppers don't want to fix it and the workers can't be bothered to make sure it is off.	Education/ enforcement/ apathy
When we go to the range or FTX we automatically fill a water buffalo, even if we will never make it through that amount of water. We don't want the water to sit until the next range so we pour it out on the way back to the Motor Pool.	Army practices
Soldiers in particular have no regard for the amount of water that they use while on duty. I've seen them run a high output hose for hours just to flush a system. Or, they will simply let a hose run because there is no "real" reason for them to shut it off.	Army practices
Public Works should learn how to adjust the self-flushing toilets so they don't waste so much water each flush – some toilets run for a very long time.	Fixtures
Don't understand why all urinals in the Army are not the no-flush versions. It's proven technology.	
Much misuse of water from pipes leaking, freezing and bursting and not being found in a timely manner and faucets left running. Example: when the automatic flush toilets get "stuck" and continually flush. The button gets jammed in and there is no obvious way to fix it.	Repair / maintenance of pipes and fixtures

Housing on Fort Riley has a policy in place encouraging people to keep their lawns watered. To help conserve water, the policy should be addressed and alternate, water friendly landscaping should be considered.	Housing & landscaping standards
Some military housing uses way too much water for yards. I think Ft. Riley can stop watering yards, golf course, ball fields, and parade field, what a waste. Use natural grasses like Bermuda, which tolerates the heat and drought better than fescue, or Kentucky 31.	
I think the thing that wastes the most water is running the water for so long waiting for the hot water. The hot water system is very inefficient and causes a lot of wasted water waiting for it.	Inefficiency
The water sprinklers on Ft Riley are on a timer and I still see them watering the lawns during or right after a rain in the area. Now that is a waste of water.	Inefficiency

Conclusions/Discussion

Responses to this survey indicate that participants are aware of high consumption uses and report they have already adopted water conservation behaviors, which may support their self-appraisal of having average or below average water use. Similarly, they reported awarenes of the importance of water conservation generally and in particular for Fort Riley and the Army. In addition, most participants report a strong pro-environmental attitude and agree that water conservation programs are necessary. They expressed the opinion that “everyone should make an equal effort.”

This opinion is supported by their beliefs regarding who bears responsibility for protecting water resources, i.e., individuals, Garrison commander, and local entities. About 77% of respondents reported a belief in individual responsibility for water protection, and about 52% of respondents believe individuals are effective (somewhat, moderately, or very) in protecting water resources. These responses reflect the general cultural values of individual-level responsbility for behaviors, and individual-level efficacy at resolving problems. It further suggests that this target audience would be receptive to outreach efforts to achieve Net Zero goals, especially if such efforts emphasize individual the power of individuals to make a difference (as opposed to, for example, top-down restrictive or punitive approaches). To the question of who bears responsibility for proteching water resources, about 25% of respondents selected an “I don’t know” response. This 25% may be open to an outreach campaign that emphasized the effectiveness of individual action.

Attitudes regarding water re-use also seem optimistic, despite nearly 50% being uncomfortable with re-using water for drinking water. Comments on water re-use support the idea that trust is a key issue to be overcome—trusting the responsible entity that re-captured water will be adequately cleaned and treated.

Limitations

The survey sample was small. Delivery of the survey limited recipients to workers with computers, excluding workers whose duties do not require the use of a computer. Finally, because of the survey delivery method available to the researchers, follow-up contact with specific survey recipients was not possible.

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APPENDIX

Fort Riley Net Zero Water

1st in Water Conservation

Welcome to the Fort Riley Net Zero Water Research Survey!

In 2011, the Army created the Net Zero initiative to advance sustainability. The net zero concept is founded upon the idea of consuming natural resources responsibly based upon knowledge of long-term resource availability, creating a sustainable environment to support an installation's long-term mission. The Army is pursuing net zero programs in energy, water, and solid waste. Fort Riley is one of eight net zero water pilot- sites. A Net Zero Water Installation limits the consumption of freshwater resources and returns water back to the same watershed so not to deplete the groundwater and surface water resources of that region in quantity and quality through the course of a year.

This survey will help the Army better understand how soldiers, their families, and other people working and living on Ft Riley feel about water conservation and the technical and behavioral drivers of water demand. The aim is to establish a snapshot of where attitudes and behavior are now (this survey) and then track changes in these areas as the Net Zero initiative progresses. The results will help the Army tailor net zero messages and programs (both here at Ft. Riley and elsewhere) to the unique context of life and work on base.

This survey is voluntary; and should take approximately 15-20 minutes to complete. If you have questions or concerns regarding the survey, please contact: Dr. Gerad

Middendorf, Department of Sociology, Anthropology, and Social Work at Kansas State University (middendo@ksu.edu, 785-532-4960) or Dr. Terrie A. Becerra, Department of Sociology, Anthropology, and Social Work at Kansas State University (tabecerra@ksu.edu, 785-532-6865). Responses to these survey questions will be kept confidential, and your participation is voluntary. For reporting purposes, your responses will be combined with those from other survey respondents, and reported in the aggregate. No information will be connected to an individual in any resulting reports. For compliance purposes, we would like to confirm your willingness to participate in this important survey. If you agree to participate in this survey, please select "I willingly agree to participate under the terms described above" and click "Continue." By this selection, you are providing your informed consent to participate in this survey. If you wish to obtain a hard copy of the consent form, please print this page for your own records. You may stop taking this survey at any time.

If you do not agree to participate in this survey, select "I prefer not to participate" and click "Continue."

❍I willingly agree to participate under the terms described above.
❍I prefer not to participate.

Part I—Awareness, Attitudes, and Conservation

In this section we would like to learn about your water usage and your opinions regarding the need for water conservation in the Fort Riley region.

Have you ever heard about the importance of using less water?

❍Yes
❍No

If yes, how? Mark all that apply.

❍As a child
❍from school
❍from family
❍from television
❍from Army training
❍Other, please write in ___________________

Have you ever changed your mind about an environmental issue as a result of any of the following? Mark all that apply.

❑Attending public meetings
❑Classes or presentations
❑Conversations with other people
❑Financial considerations
❑Firsthand observation
❑From Army education or training
❑From my child telling me things she/he has learned
❑News coverage (TV, newspapers, Internet, etc.)
❑Participating in volunteer activities
❑Social Media
❑Speech by an elected official

Are you aware that . . .

	Yes	No
The Army has water use reduction goals.	❍	❍
Ft Riley is trying to reduce water use.	❍	❍

Have you ever noticed water being wasted . . . ?

	Yes	No
At your home station?	❍	❍
During field training?	❍	❍
While deployed?	❍	❍

Please mark your level of agreement with the following statement.
It is important to save water . . .

	Least Important	Somewhat Important	Moderately Important	Important	Very Important	I don't know
When I am at my home station.	❍	❍	❍	❍	❍	❍
During field training.	❍	❍	❍	❍	❍	❍
While I am deployed.	❍	❍	❍	❍	❍	❍

Do you know how to report water waste . . . ?

	Yes	No
At your home station?	❍	❍
During field training?	❍	❍
While you are deployed?	❍	❍

Do you know how much water you use? (In a day, week, month?) I believe my use is

❍Below average
❍Average
❍Above average
❍I Don't know

Which of these activities do you think uses the most water? Select one.

❍Brushing my teeth
❍Running the dishwasher
❍Running the washing machine
❍Showering or bathing
❍Washing my hands
❍Watering the yard

Please mark your level of agreement with the following statement:
I think about the way I use water around the house/barracks/workplace and try to save water whenever possible.

❍Strongly Disagree
❍Disagree
❍Neither Agree nor Disagree
❍Agree
❍Strongly Agree

Please indicate if you or members of your household employ any of the following to conserve water. Mark all that apply.

❍Take short showers (5 minutes or less)
❍Turn off the faucet while brushing your teeth or shaving
❍Lower the water level of the washing machine for smaller loads
❍Check for or repair water leaks around the house/barracks
❍Collect cold water for other uses while waiting for water to heat up
❍Adopted new technologies (low flow faucets or other water saving appliances)
❍Use dishwasher with only a full load
❍Wash dishes by hand
❍Changed the way your yard is landscaped
❍Changed how often you water your yard
❍Redirect downspouts towards lawn/ plants
❍Rainwater harvesting
❍Other (please specify) ___________________

Thinking about other environmentally friendly behaviors, in your day-to-day life do you . . .
Mark all that apply.

❍Avoid chemical use in your yard or garden?
❍Buy biodegradable or recyclable products?
❍Donate money to environmental organizations to address water or other environmental issues?
❍Recycle?
❍Reduce household trash by buying products that come with less packaging?
❍Turn down the thermostat at night or when leaving for the day?
❍Turn off air conditioning when leaving a room?
❍Turn off lights when you leave a room?
❍Watch environmental shows on television?

Below are scenarios that may or may not motivate you or members of your household/barracks to conserve water. Please mark the scenarios that you feel would motivate you or members of your household/or residents of your barracks to conserve water. Mark all that apply.

❍Severe drought
❍Substantial increase in water bill
❍Reduced rates for reduced water use
❍Free low-flow device(s)
❍Vanishing wildlife habitats
❍Growing number of endangered species
❍Pollution of freshwater
❍Disappearing wetlands
❍Reduced agricultural yields
❍Mandatory regulations
❍Other (please specify a scenario) ____________________

Of the statements listed below, please mark all that would prevent you or members of your household/barracks from conserving water. Please mark all that apply.

❑I don't know if household conservation efforts are effective.
❑I don't think my household is wasting water.
❑Residential users do not use enough water to make a difference in water conservation efforts.
❑I don't know how to conserve water.
❑I have the right to use any amount of water I choose.
❑Other (Please specify a reason) ____________________

How important are each of the following water issues to you?

	Not important	Somewhat important	Moderately Important	Very important	I don't know
Clean drinking water	❍	❍	❍	❍	❍
Clean rivers and lakes	❍	❍	❍	❍	❍
Clean groundwater--water in the ground that supplies wells.	❍	❍	❍	❍	❍
Clean water for recreation	❍	❍	❍	❍	❍
Clean water for aquatic habitat (fish, ducks, etc.)	❍	❍	❍	❍	❍

How do you see yourself on environmental and natural resource issues? Please rate yourself on a scale from 1 to 5.

❍1 - Total natural resource use
❍2
❍3 - Equal balance between use and protection
❍4
❍5 - Total environmental protection

Part II—Water Conservation

In this section we would like to learn about your opinions regarding the need for water conservation in the Fort Riley region specifically.

The Fort Riley region is an eight county area including Clay, Saline, Dickinson, Morris, Geary, Riley, Pottawatomie, and Wabaunsee counties.

Please indicate your level of agreement with the statements below.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The need to conserve water is real.	❍	❍	❍	❍	❍
The Fort Riley region has enough water to meet the current and future needs (10 years from now) of its citizens.	❍	❍	❍	❍	❍
The Fort Riley region has enough water to meet the current needs of its citizens, but it will be more difficult to meet future needs.	❍	❍	❍	❍	❍
The Fort Riley region does not have enough water to meet the current or future needs of its citizens.	❍	❍	❍	❍	❍

I believe the likelihood of the Fort Riley region suffering from a prolonged drought is

❍Decreasing
❍Staying the Same
❍Increasing
❍I don't know

What is the water supply source for Ft. Riley? Select one.

❍Private Supply (private well, river, pond, lake)
❍Public Supply (City or rural water system)
❍Well system (well serving 15 or more residences, but not a city system)
❍I don't know

I am concerned about the issue of residential water use in the Fort Riley region.

❍Strongly Disagree
❍Disagree
❍Neither Agree nor Disagree
❍Agree
❍Strongly Agree

Thinking about the focus of water conservation programs like Net Zero, please mark your level of agreement with the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Every drop counts. Everyone should make an equal effort to conserve water wherever possible	❍	❍	❍	❍	❍
These programs should focus only on excessive or careless water users	❍	❍	❍	❍	❍
These programs are not necessary. People are entitled to use as much water as they like and we should trust them to make the right decisions.	❍	❍	❍	❍	❍

Part III—Responsibility for protecting water resources

In this section we ask you about responsibility for protecting water resources and the effectiveness of conservation programs.

Do you think protecting our drinking water supply is . . .?

❍Not important
❍Somewhat important
❍Very important
❍I don't know

Who do you think should be most responsible for protecting water resources? Please mark all that apply.

❑Federal government
❑State government
❑Local governments (county, city or town)
❑Other local government entity
❑Private entities (industries, businesses, groups, organizations)
❑Individuals (private citizens, soldiers)
❑I don’t know

Regarding military installations, who do you think should be most responsible for protecting water resources? Please mark all that apply.

❍Department of Defense
❍Environmental Protection Agency
❍Garrison Commander & Directorate of Public Works
❍Public Health Command
❍Commanding General
❍Individual soldiers
❍State government

How effective do you feel each one of these groups is in fulfilling their responsibility for protecting water resources on Ft. Riley?

	Very Ineffective	Somewhat Ineffective	Somewhat Effective	Moderately Effective	Very Effective	I don't know
Federal government	❍	❍	❍	❍	❍	❍
State government	❍	❍	❍	❍	❍	❍
Fort Riley	❍	❍	❍	❍	❍	❍
Individuals (private citizens or individual soldiers)	❍	❍	❍	❍	❍	❍

Part IV—Water Re-use

Water re-use is the practice of capturing, cleaning, and/or treating and reusing water that has already been used. The next set of questions asks about your comfort level in reusing water that has been captured from hand washing, showering, and laundry and then re-used.

The healthiness and well-being of soldiers, family members, and/or the civilian and contractor work force is a top priority of the Army . . .

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When I am at my home station.	❍	❍	❍	❍	❍
During field training.	❍	❍	❍	❍	❍
While I am deployed.	❍	❍	❍	❍	❍

I am confident the Army has adequate procedures in place to clean and treat water for re-use . . .

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When I am at my home station.	❍	❍	❍	❍	❍
During field training.	❍	❍	❍	❍	❍
While I am deployed.	❍	❍	❍	❍	❍

As long as it is properly cleaned and treated, I am comfortable reusing water captured . . .

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree		Strongly Agree
from hand washing for hand washing	❍	❍	❍	❍	❍	❍
from showering for	❍	❍	❍	❍	❍	❍

showering						
from laundry for laundry	❍	❍	❍	❍	❍	❍
from hand washing, showering or laundry for re-use in hand washing	❍	❍	❍	❍	❍	❍
from hand washing, showering or laundry for re-use in showering	❍	❍	❍	❍	❍	❍
from hand washing, showering or laundry for re-use in laundry	❍	❍	❍	❍	❍	❍

As long as it is properly cleaned and treated, I am comfortable reusing water captured . . .

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
From hand washing for re-use as drinking water.	❍	❍	❍	❍	❍
From showering for re-use as drinking water.	❍	❍	❍	❍	❍
From laundry for re-use as drinking water.	❍	❍	❍	❍	❍

Part VI—Demographic

What is your home state?

(list of 56 options—50 states plus American Samoa, District of Columbia, Guam, Northern Marianas Islands, Puerto Rico, Virgin Islands)

How many persons live in your household? (Write in number)

What is your gender?

❍Male
❍Female
❍I prefer not to answer

Please specify your race/ethnicity. Please mark all that apply.

❑African American/Black
❑Asian
❑American Indian/Alaskan Native
❑Native Hawaiian/Pacific Islander
❑White
❑I prefer not to respond.

In what year were you born?

❍Write in the year ____________________
❍I prefer not to respond.

What level of formal education have you completed?

❍Less than High School
❍High School graduate, includes equivalency
❍Some college
❍Bachelor's degree
❍Master's degree
❍Professional school degree
❍Doctorate degree

What is your gross household income?

❍Less than $36,000 per year
❍36,000 – 49,999
❍50,000 – 69,999
❍70,000 – 99,999
❍100,000 – 130,000
❍130,001 – 150,000
❍More than $150,000 per year
❍I prefer not to respond.

Net Zero Survey

Thank you for taking the time to complete the questionnaire!

Your contribution to this effort is greatly appreciated.

Your responses will be aggregated with those from other participants.

If you have questions or concerns regarding the survey, please contact:

Dr. Terrie A. Becerra (tabecerra@ksu.edu)

Or

Dr. Gerad Middendorf (middendo@ksu.edu, 785-532-4960)

Moving Towards a Real-Time Drought Assessment and Forecasting System for Kansas

Basic Information

Title:	Moving Towards a Real-Time Drought Assessment and Forecasting System for Kansas
Project Number:	2014KS170B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-001
Research Category:	Climate and Hydrologic Processes
Focus Category:	Drought, None, None
Descriptors:	None
Principal Investigators:	Xiaomao Lin, Robert Aiken, Gerard J. Kluitenberg, Daniel OBrien

Publication

1. Zhang, T., X. Lin, D. H. Rogers, and F. R. Lamm. 2015: Adaptation of irrigation infrastructure on irrigation demands under future drought in the USA. Earth Interactions doi: http://dx.doi.org/10.1175/EI-D-14-0035.1

KIWR Project Progress Report in 2015 (from March 2015 to Feb 2015)

Moving Towards A Real-Time Drought Assessment and Forecasting System for Kansas

Xiaomao Lin, Gerard Kluitenberg, Robert Aiken, and Daniel O'Brien

This study has three objectives which were:

1) To construct an integrated drought-related dataset, suitable for Kansas drought assessment and forecasting;

2) To develop computational tools for computing three drought indices: *Palmer Drought Severity Index* (PDSI), *Standardized Precipitation Index* (SPI), and *Standardized Precipitation Evapotranspiration Index* (SPEI); and

3) To analyze historic drought episodes, establishing Kansas's benchmark metrics for detecting the onset, duration, severity and frequency of drought.

During the period of March 1, 2015 to Feb. 28, 2015, we have successfully completed Objective 1 and Objective 2. We constructed an integrated dataset for drought assessment including temperature, precipitation, and top soil data for drought indices for the entire Kansas as well as around 60 stations surrounding Kansas from 1900 to 2014. The datasets have been tested and testing results were reasonable well. Two investigators in this project have separately completed computation tools for calculating three indices of drought, that is, PDSI, SPEI, and SPI. These two independent developments for computation codes were very helpful for validating our computation algorithms along with original developers. Our comparison between our two computation tools was quite well. We delivered one product that is distributed in the website: Kansas drought at http://climate.k-state.edu/drought/ Note that this product contains all monthly drought from 1900 to 2014. We expect that we will update Kansas drought information on a monthly basis to the current month.

Regarding to the Objective 3, we partially completed this objective, which was manly conducted by a graduate student, Zach Zambreski who is 50% supported by this project. We will present our results for Objective 3 in 2015 ASA meeting. In addition to Objective 3, we are also working on the forecasting data for Kansas, which are large-volume data sets that we are manipulating and processing. We anticipate we perhaps can provide a drought warning tool for Kansas producers, and public agencies in near future.

In terms of graduate student's training in this project, Zach Zambreski (MS student) is a recipient of Timothy R. Donoghue Graduate Scholarship. We planned to send him in the 2015 ASA conference. We also planned to send him for a 10-day field working training in Bushland Texas in June 2015.

During the past year, we have three invited presentations and one article was published and one manuscript is in preparation. These publications are

Invited talks from our project

1. Lin, X., G. Kluitenberg, R. Aiken, M. Knapp, 2014: Kansas droughts: history, current, and future. Governor's Conference on the Future of Water in Kansas. Nov. 2014. Manhattan, KS.

2. Lin, X., G. Kluitenberg, R. Aiken, M. Knapp, 2014: Kansas droughts: history, current, and future. The Kansas Hydrology Seminar, University of Kansas. Dec. 2014. Lawrence, KS.
3. Lin, X. 2015: Kansas drought characteristics over last century. The Drought warning assessment workshop. March, 2015. Lincoln, NE.

Manuscript in preparation

Zambreski Z. X. Lin, G. Kluitenberg, R. Aiken 2015: The spatiotemporal characteristics of drought occurrences in Kansas using multiple indices. *International journal of climatology*. It will be submitted in Aug. 2015.

Published article

Zhang, T., X. Lin, D. H. Rogers, and F. R. Lamm. 2015: Adaptation of irrigation infrastructure on irrigation demands under future drought in the USA. *Earth Interactions* doi: http://dx.doi.org/10.1175/EI-D-14-0035.1

Extending the Useable Life of Ogallala Aquifer through Limited Irrigation using Integrated Sensor-Based Technologies

Basic Information

Title:	Extending the Useable Life of Ogallala Aquifer through Limited Irrigation using Integrated Sensor-Based Technologies
Project Number:	2014KS171B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-001
Research Category:	Ground-water Flow and Transport
Focus Category:	Irrigation, None, None
Descriptors:	None
Principal Investigators:	Isaya Kisekka, Jonathan P Aguilar, Randall Currie, Danny H. Rogers

Publication

1. Kisekka, I., J. Aguilar, F.R. Lamm, and D. H. Rogers. 2014. Using Soil Water and Canopy Temperature to Improve Irrigation Scheduling for Corn. Technical Proceedings of the 2014 Irrigation Association Technical Conference, Phoenix, Arizona, November 19-20, Available at: from the Irrigation Association, Falls Church, Virginia.

Title: **Extending the usable Life of Ogallala Aquifer through Limited Irrigation using Integrated Sensor-Based Technologies**

Research Category: Ground-water Flow and Transport

Focus Category: Irrigation

Primary PI: Isaya Kisekka, Kansas State University (KSU) Southwest Research and Extension Center (SWREC), E. Mary St., Garden City, KS, ikisekka@ksu.edu, (620)-275-9164.

Other PIs: Jonathan Aguilar, KSU SWREC, E. Mary St., Garden City, KS, jaguilar@k-state.edu, (620)-275-9164, Danny Rogers, KSU, Biological and Agricultural Engineering Department, 151 Seaton Hall Manhattan, KS, drogers@ksu.edu, (785) 532-2933 and Randall Currie (SWREC, Garden City, KS), KSU SWREC, E. Mary St., Garden City, KS, rscurrie@ksu.edu, (620)-275-9164.

Executive Summary

With declining well capacities in the Central High Plains resulting from withdrawals exceeding recharge in the Ogallala aquifer, producers will need to adopt advanced irrigation scheduling to maintain productivity with limited water. A study is being conducted to assess the effect of 3 irrigation scheduling approaches on corn growth, yield, and water productivity, and water use of conventional and drought tolerant hybrids. Irrigation scheduling approaches based on soil and plant water status monitoring as well as weather monitoring are being evaluated. The study involves five irrigation scheduling treatments applying 80% of full irrigation and a control (full irrigation) treatment and two corn hybrids arranged in a split-plot RCBD design.

Preliminary results from year 1indicate there were no significant differences in yield among irrigation scheduling methods (p-value=0.38). However, there were significant differences in yield between conventional and drought tolerant corn hybrids (p-value=0.003), on average there was a 20% yield advantage for the conventional hybrid. The effect of interactions between irrigation scheduling method and corn hybrid on corn yield was not significant (p-value=0.48). Treatment T2 based on crop water stress sensing using the Time Temperature Threshold used 11% more water compared to the standard irrigation scheduling method based on neutron probe monitoring (T1). But T2 resulted in the highest yield for the drought-tolerant corn hybrid (189 bu/ac). Treatment T3 that triggered irrigation based on soil water sensors resulted in 22% more water applied compared to the standard method. But T3 also resulted in the highest yield (219 bu/ac) for the conventional corn hybrid. Yields appear to have been affected by hail damage that occurred earlier in the season (at growth stage V14) resulting in reduced canopy cover.

Residual soil water effects from a previous study also influenced yields, with treatments located in high water level areas producing higher yields compared to those in low water level locations. Preliminary data indicates that soil-based, plant-based, or climate-based irrigation scheduling can result in improved crop water productivity particularly under non-ideal growing environments where external abiotic and biotic factors could influence in-season crop water use. Matching irrigation applications with crop use under non-ideal environments could help producers to maintain profitability and conserve water. Integrating soil and plant water status monitoring with the scientifically robust ET-based scheduling could encourage more producers to adopt irrigation scheduling through visual illustrations of root water uptake.

Experimental site characteristics

The study is being conducted at the Kansas State University Southwest Research and Extension Center Finnup farm (38^{o}01'20.87''N, 100^{o}49"26.95W, elevation of 2910 feet above mean sea level) near Garden City, Kansas. A four span (140 feet span width) lateral move sprinkler irrigation system (model 8000, Valmont Corp., Valley, NE) is being used to apply irrigation water. The experimental design is a split-plot randomized complete block design with four replications. Each span is a replication with six randomized treatments. Irrigation scheduling is the main factor while sub plots are corn hybrids (drought tolerant and conventional) as shown in Fig.1.

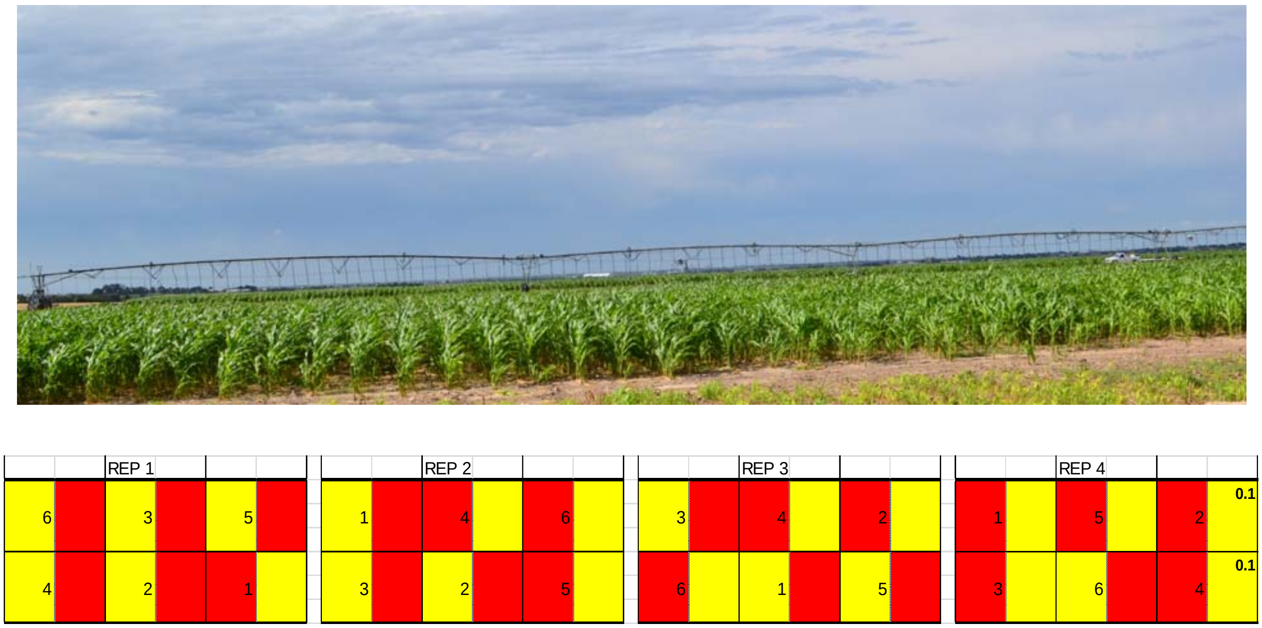

Figure 1. Linear move sprinkler system and split-plot randomized complete block design experimental layout where numbers within the plots represent irrigation treatment and yellow and red colors present conventional and drought tolerant corn hybrids respectively, at Kansas State University SWREC near Garden City, Kansas.

Irrigation Water Management Treatments

The six irrigation scheduling treatments evaluated are:

1. Irrigate when available soil water (ASW) in the root zone falls below 60% ASW based on weekly soil water measurements with a neutron probe.
2. Irrigate when the canopy temperature time-temperature-threshold (TTT) exceeds 28^{o}C for more than 240 minutes.
3. Irrigate when ASW in the root zone falls below 60% ASW based on soil water sensor measurements.
4. Irrigate when the crop water stress index (CWSI) threshold exceeds 0.3 or ASW falls below 60% based on soil water sensor measurements
5. Irrigate only if data from both soil water and CWSI indicate that thresholds have been exceeded
6. Control treatment replenishing 100% ET (Full irrigation)

An ET-based water budget is being kept for each treatment. Each irrigation event applies 1 inch and replenishes only 80% of the accumulated ET with the exception of treatment 6.

Soil Water Status Sensing

Soil water sensors were installed to serve as checks on the adequacy of the ET-based irrigation schedules and also to indicate need for irrigation. Soil water sensors (CS655; Campbell Scientific Inc., Logan UT, USA) were installed in treatments 3, 4, and 5 in the drought tolerant hybrid. Soil water sensors were only temporally installed in rep 1 during the first year of the study (2014) due to delays in procuring the sensors and wet conditions in the early part of the season that made field operations difficult. Each set of soil water sensors comprised of three sensors placed at depths of 1, 2, and 3 feet as shown in Fig. 2. However, soil water sensors will be permanently installed in all the replications during the second of the study (2015).

Figure 2. Different stages of installing CS655 soil water sensors in a corn plot during the 2015 summer growing season at Kansas State University SWREC near Garden City.

Plant Water Status Sensing

Infrared radiometers (SI-111: 22° half angle field of view, spectral range 8 to 14 µm, Apogee Instruments Inc., Logan UT, USA) were installed within 3 experimental plots for monitoring canopy temperature in drought tolerant corn hybrids. A total of 12 infrared radiometers were required in treatments 2, 4, and 5 by four replications. The sensors were positioned approximately 3 feet above the crop canopy at a 45° from the horizontal view angle as shown in Fig. 3.

Figure 3. Monitoring corn canopy temperature using thermal infrared radiometers during the 2014 summer growing season at the Kansas State University SWREC near Garden City, Kansas.

Preliminary Results

Average preliminary treatment yields and seasonal crop evapotranspiration for the two corn hybrids are summarized in Table 1. Yields did not differ significantly (p-value=0.38) across the five irrigation scheduling treatments. This means any of the three irrigation scheduling approaches evaluated could be used to schedule irrigation efficiently. There were significant differences between drought tolerant and conventional corn hybrids (p-value=0.003). The interactions between irrigation scheduling method and corn hybrid did not have a significant effect on yield (p-value=0.45).

Table 1. Yield response to irrigation scheduling method and corn hybrid during the 2014 growing season at Kansas State University SWREC near Garden City, Kansas.

Treatments	Yield (bu/ac)		Yield (bu/ac)		Seasonal ETc (in)	
	Conventional	Std.[1]	Drought Tolerant	Std.	Conventional	Drought Tolerant
T1	206	32	181	18	22 (2)[2]	21 (2)
T2	209	13	189	13	25 (1)	26 (1)

T3	219	23	179	23	25 (2)	24 (2)
T4	182	26	186	17	24 (1)	24 (0)
T5	192	12	173	22	23 (1)	23 (2)
T6	189	8	173	32	25 (1)	25 (1)

[1]Standard Deviation

[2]Numbers in parentheses are standard deviations

The number of irrigation events, irrigation frequency and total irrigation is summarized in Table 2. Of all the treatments, the standard irrigation scheduling method based on monitoring soil water using the neutron probe and a threshold of 60% plant available water required the least amount of water. Treatment 2 based on the TTT required 11% more water, while treatments 4 and 5 required 33% and 11% more water compared to treatment 1 respectively. Treatment 3 based on using a calibrated CS655 soil water sensor required 22% more water compared to treatment 1, this treatment also resulted in the highest yield for the conventional corn hybrid. Average crop water productivity (CWP) and irrigation water use efficiency (IWUE) are summarized in Table 3. The conventional corn hybrid had higher crop water productivity compared to the drought tolerant hybrid.

Table 2. Irrigation applications, frequency and total irrigation applied to five deficit irrigation scheduling treatments (80% of full irrigation) and control (full irrigation) during the 2014 growing season at Kansas State University SWREC near Garden City, Kansas.

Treatment	Number of Irrigation Events	Irrigation Frequency (days)	In-season Irrigation[2] (in)	Total Irrigation (in)
T1	7	6.7	7	9
T2	8	6.0	8	10
T3	9	5.4	9	11
T4	10	5.6	10	12
T5	8	6.0	8	10
T6 (Full)	12	4.5	12	14

[1]Irrigation applied before crop emergence

Table 3. Crop Water Productivity and Irrigation Water Use Efficiency for 5 deficit irrigation scheduling methods and a control (full irrigation) during the 2014 growing season at Kansas State University SWREC near Garden City, Kansas.

Treatments	CWP (bu/ac-in)		IWUE (bu/ac-in)	
	Conventional	Drought Tolerant	Conventional	Drought Tolerant
T1	12.4 (2.1)	10.6 (1.1)	29.5 (4.5)	25.8 (2.6)
T2	12.9 (0.9)	10.7 (0.8)	26.2 (1.6)	23.7 (2.6)
T3	13.0 (1.7)	10.7 (1.3)	24.3 (2.6)	19.9 (1.7)
T4	11.3 (1.2)	10.7 (1.4)	18.2 (2.6)	18.6 (1.7)
T5	12.0 (0.7)	10.7 (1.0)	24.0 (1.5)	21.7 (2.7)
T6 (Full)	11.1 (0.3)	9.7 (2.4)	15.8 (0.7)	14.4 (2.7)

[1]Standard Deviation

[2]Numbers in parentheses are standard deviations

Root Water uptake

The soil water sensors were used to track wetting (from irrigation or rainfall) and drying cycles as shown in Figure 4 and root water uptake during the day and near zero transpiration during the night as shown in Figure 5. These types of data could be used to determine rooting depth; which could be useful in characterizing soil water extraction patterns of different hybrids. This data on root zone water up take may increase the confidence of users of ET-based scheduling.

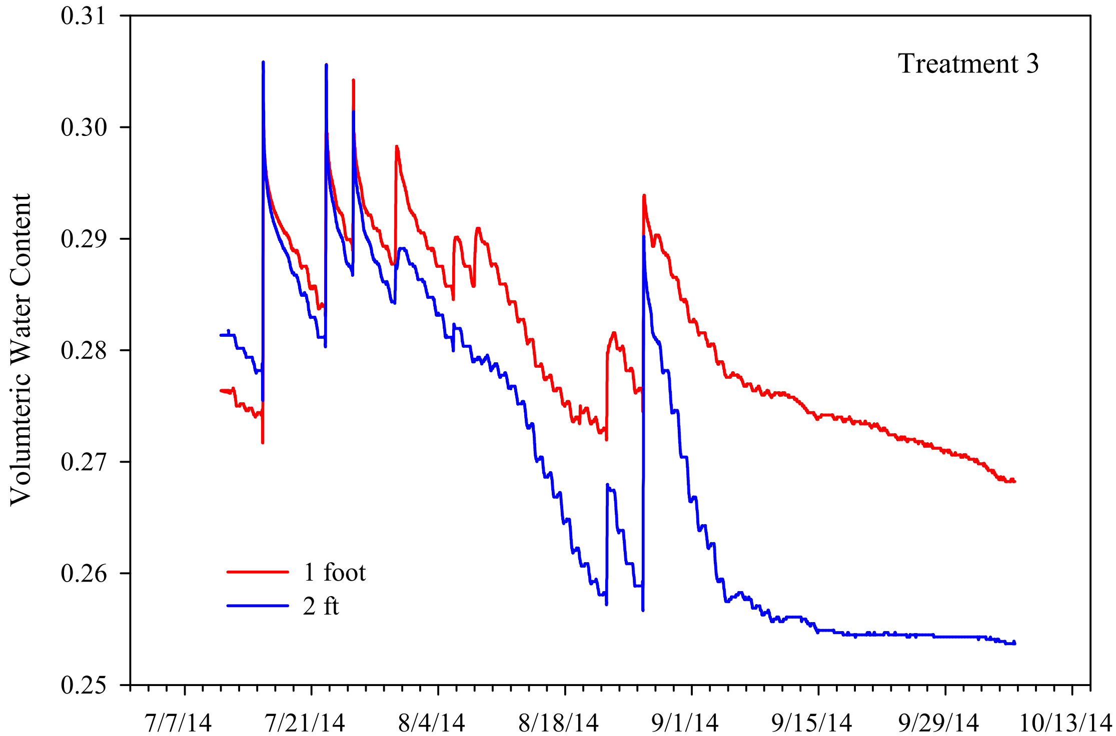

Figure 4. Soil water measurements at two different depths over time made by the CS655 soil water during the 2014 corn growing season at Kansas State University SWREC near Garden City, Kansas.
Garden City Kansas.

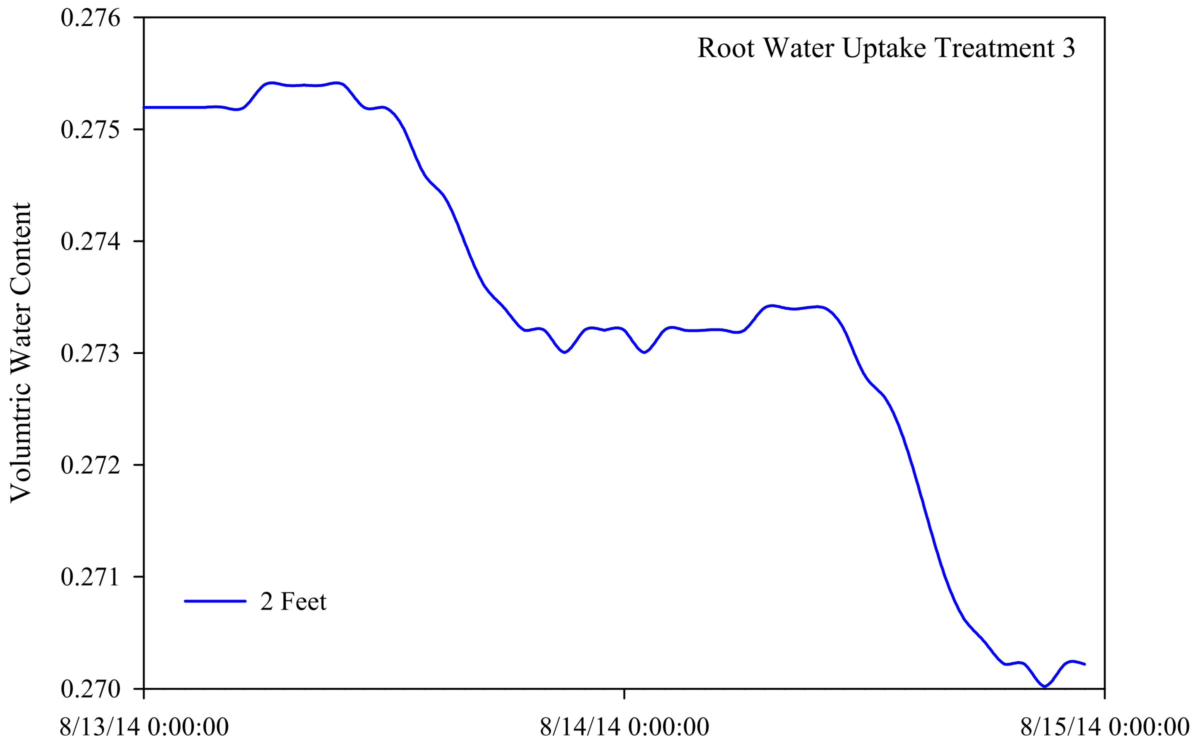

Figure 5. Illustration of root water uptake during the day and close to zero up take during the night.

Publication from this Grant:

Kisekka, I., J. Aguilar, F.R. Lamm, and D. H. Rogers. 2014. Using Soil Water and Canopy Temperature to Improve Irrigation Scheduling for Corn. Technical Proceedings of the 2014 Irrigation Association Technical Conference, Phoenix, Arizona, November 19-20, Available at: from the Irrigation Association, Falls Church, Virginia.

Student Trained: Mr. Tobias Oker PhD Bio and Ag Engineering will mainly be trained in year 2.

Assessment of Deteriorating Water Quality in the Ogallala Aquifer and its Effect on Crops in Western Kansas

Basic Information

Title:	Assessment of Deteriorating Water Quality in the Ogallala Aquifer and its Effect on Crops in Western Kansas
Project Number:	2014KS172B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-001
Research Category:	Water Quality
Focus Category:	Water Quality, None, None
Descriptors:	None
Principal Investigators:	Jonathan P Aguilar, Isaya Kisekka, Danny H. Rogers, Aleksey Sheshukov

Publications

There are no publications.

Progress Report for
Kansas Water Resources Institute Project

ASSESSMENT OF DETERIORATING WATER QUALITY IN THE OGALLALA AQUIFER
AND IT'S EFFECT ON CROPS IN WESTERN KANSAS

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Goals and Objectives

The overall goal of this project is to establish baseline information on the status of water quality of the Ogallala Aquifer as it relates to the major agricultural crops in the region. The project objectives will be to: 1) quantify the spatial extent of water quality deterioration in areas underlain by the Ogallala Aquifer 2) evaluate the effect of varying concentrations of specific chemical constituents primarily chloride and sulfate on crop growth; and 3) encourage participation of a student into the field of water resources.

Study Activities

Planning and Survey: The project team started identifying and mapping all the center pivots that show signs of deteriorating water quality. The primary criterion was the presence of PVC pipes retrofitted below the main center pivot structure. These PVC retrofitted center pivots were initially very prevalent in the Arkansas River corridor in southwest Kansas, understandably because of the saline condition of the water in this river. However, in recent years, there is noticeable number of these systems found further south of the Arkansas River corridor. Our strategy was to drive around highways and county roads to map all PVC retrofitted center pivots in southwest Kansas.

To date, we were able to identify and map more than 225 of these PVC retrofitted center pivots with almost half of them are located outside the Arkansas River corridor (Figure1). Initial analysis shows that many of these center pivots are adjacent to cattle feedlots that either are using the center pivots to apply the waste water to an adjacent land or are having localized water quality issues. However, the most interesting observation is that many of these center pivots are clustering to at least three areas (e.g. northeast of Johnson City, border of Haskell and Grant counties along US Highway 160, and south of Sublette along US Highway 83) where there seems to be no obvious reasons of water quality issues. We have shown these clustering to the Groundwater Management District 3 (GMD3) and Kansas Division of Water Resources personnel familiar with the area and they seem to be surprised as well about the evident clustering.

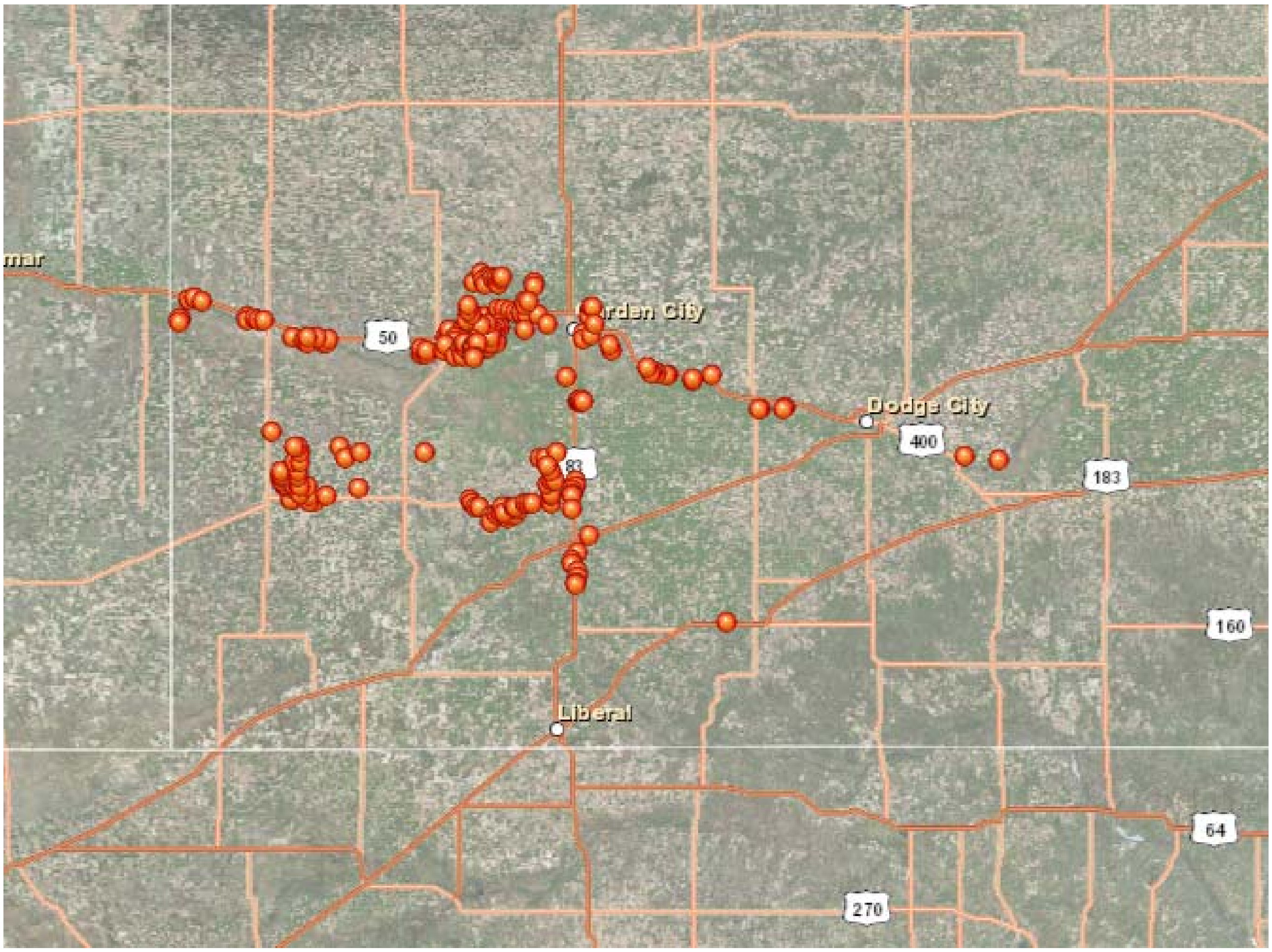

Figure 1. Location of the PVC retrofitted center pivots across southwest Kansas for the year 2014.

Water Sampling and Analysis: One of the activities we initiated last year was a widespread dissemination and education on the importance of water quality testing even on wells were water quality does not seem to be an issue. We collected samples from several wells and submitted them to a private laboratory, Servi-Tech for irrigation water quality analysis. One concrete positive result of our efforts was the establishment of a new program of the Garden City Company to encourage and collect yearly water quality testing on all the wells (around 50 wells) within their command area. They contacted us and offered to share the database of these water quality tests from this year onwards. Most of these wells are located within the Arkansas River corridor where majority of the PVC retrofitted center pivots could be found.

Based on the initial mapping results, we will now initiate strategic water quality sampling particularly in areas with clustering. Our sampling strategy is to collect water samples from the wells adjacent and within the clusters on a North-South and East-West transects. We have already identified the wells and are now waiting for the GMD3 to release to us the contact information of the well owners for proper notification.

Plant Testing: Last year we geared-up to test the response of some crops to different levels of electrical conductivity (EC) of water. However, late in the month of May we were informed that the greenhouse where we have set-up the experiment experienced a major problem in its cooling system. Apparently, it needs is a major repair and could take several weeks before it could be restored. The other greenhouse in the station was damaged by a hailstorm. The team decided to abandon this objective for several reasons. First, it was now too late transfer the set-up to an outside plot since most crops have already been planted and it will now be logistically difficult to carryout the experiment. Second, the student helper was only available until the end of July so the experiment would be difficult to finish in a timely manner. And third, since we might not have the same scenario as with the second year, the experiment would be difficult to justify as a true replication of each year. We have informed the overall coordinator, Dr. Dan Devlin, of these changes and offered to reallocate our resources to the other objectives.

Mapping and Geo-Statistical Analysis: After having mapped all the PVC retrofitted center pivots, we will perform the geo-statistical analysis once we have the water quality test results from the wells.

A Success Story

<u>Objective: Encourage participation of a student into the field of water resources:</u> On the first year of the project, a student from the Garden City Community College (GCCC) was hired to work as summer student help. The student, Bruce Niere, was taking an Associate Degree in Graphic Designs and has very minimal experience in agriculture and water resource. While doing fieldwork, he usually asks questions regarding how crops are grown, how they respond to irrigation, and why water quality matters, among others. Throughout the summer, he gained appreciation on the importance of the research activities we were conducting at SWREC.

Last December he graduated from GCCC with honors. Mr. Niere then moved-out from Garden City to Kansas City to work. Early spring, I contacted him to see how he is doing and told him that we are again looking for students that could work for us over the summer. I was surprised when he expressed interest on the work. Recognizing his work ethics, flexibility in schedule over a student, and keen interest to agriculture and water resource research, I offered him an Agricultural Technician position. He quit his job in Kansas City and is now working full time in

SWREC helping not only in this project but also in some of our irrigation activities. He is also involved in developing informational materials related to agriculture and water resources using his academic training on graphic design.

I consider this a fulfillment of the third objective of this project, encouraging participation of a student into the field of water resources. Mr. Niere made a significant shift in his career by not only going back to work with SWREC where he started as student, but by utilizing his skills towards agriculture research and extension activities. I would not be surprised if he pursues his career further or take additional courses toward a higher degree now that he could see the relevance of his skills. I believe that though his passion is still graphic design, he is using talents and skills towards the field of water resources and agriculture, thus a success story for KWRI's overall goal.

Future Work

This year, we will perform more water quality sampling and analysis especially in the areas where clustering of PVC retrofitted center pivots were observed. We plan on gathering additional information from the producers, such as crop yield and water use, in those areas to detect any significant correlations. Spatial and geo-statistical analysis will then be performed to further understand the clustering and the extent of water quality issues we are dealing with. We will continue mapping any additional PVC retrofitted center pivots that we may see.

As indicated in the original project document, the information derived from this study will be shared in extension education meetings, experiment station field days and tours. Producers, policy makers, and water resource managers in the region will be apprised of the significant results in this study using different communication avenues. It is also expected that the results of this study will be pivotal information in future research initiatives regarding the water quality of the Ogallala Aquifer.

Assessing Natural Variability in Groundwater Surface Water Interactions

Basic Information

Title:	Assessing Natural Variability in Groundwater Surface Water Interactions
Project Number:	2014KS173B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-002
Research Category:	Climate and Hydrologic Processes
Focus Category:	Groundwater, Surface Water, None
Descriptors:	None
Principal Investigators:	Andrea Elizabeth Brookfield, James J. Butler

Publications

There are no publications.

Assessing Natural Variability in Groundwater/Surface Water Interactions
Year 1 Progress Report

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Research Needs & Project Goals

The quantity and quality of any water resource can drastically change in both time and space. These changes can make effective water management a difficult task and can decrease the social, economic and environmental stability of the region dependent upon them. Over the past decade, the Great Plains region has experienced both severe drought and flood events, causing large variations in irrigation demand, soil moisture, groundwater recharge and surface water levels in the region, exacerbating water management issues and increasing stress on local ecosystems. This underscores the need to better understand how variability in climatic and hydrologic conditions affects the mechanisms that drive the spatial and temporal distribution of water.

The main goal of this research is to improve our understanding of groundwater/surface water (gw/sw) interactions and their temporal variations, and to determine the significance of these interactions to the distribution of water resources within the study area. To achieve this goal, we will address four specific objectives: 1) Automate the real-time collection of detailed data (stream stage, stream temperature, groundwater head, groundwater temperature and barometric pressure) for characterizing gw/sw interactions through time at three locations within Kansas; 2) Develop methodology to systematically quantify gw/sw interactions using these data with a focus on water-level and temperature responses in shallow near-stream wells to stream stage changes; 3) Analyze results to assess the relationship between temporal climatic and hydrologic variations and changes in gw/sw interactions; and 4) Assess the role of gw/sw interactions in the distribution of water within the study area.

Methods

This study installed real-time coupled gages to monitor groundwater and surface water levels at three locations within Kansas. To effectively utilize existing infrastructure, all three sites had existing monitoring wells located close enough to a USGS stream gage to directly connect them or use low-cost radio transmitters to transmit the data from the well to the existing telemetry systems at the USGS gage stations. All wells were equipped with Instrumentation Northwest PT2X pressure and temperature sensors. Processing the surface water and groundwater levels and temperatures from these gages will be automated as will uploading the results to a dedicated KGS webpage for this study.

The proposed monitoring program will be coupled with analytical and empirical data analysis methods and hydrologic modeling to evaluate temporal changes in gw/sw interactions in response to climatic and hydrologic variability (e.g. Theis, 1941; Zlotnik and Huang, 1999; Hantush, 2005; Teloglou and Bansal, 2012). For this research, a function for aquifer response to stream-stage fluctuations for a partially-penetrating stream will be used (Butler and Tsou, 2000).

This work will also use a multiple regression approach as presented in Spane and Mackley (2011) to assess gw/sw interactions using the water level data. This approach uses a time-domain, multiple-regression, convolution method to develop aquifer/river response function relationships. This method has been implemented in the KGS Barometric Response Function software (Bohling et al., 2011) as similar relationships have been used to remove barometric responses in groundwater levels. In this work, a series of aquifer/river response functions will be generated for each gage station based upon data collected for this study. From these functions the temporal changes in fluxes across the gw/sw interface can be assessed by comparing how changes in water levels are distributed with time for each surface water perturbation. Furthermore, the functions developed for each site will be used for future projections of groundwater levels under variable surface water levels, as induced by changes to water management strategies and extreme hydrologic events.

The temperature-based estimation of gw/sw interactions in the proposed study will utilize the method outlined in Hatch et al., 2006. This method quantifies the changes in phase and amplitude of temperature variations between temperature sensors, and uses these changes to estimate vertical fluxes between the two sensors. This method is well suited to this study as it is easily applied to long data sets, and is independent of the absolute depth of the sensors, making it insensitive to streambed scour or sedimentation. This method is dependent solely on temporal variations in temperature, and not stream stage or water level. As such, a comparison to all other analysis methods used in the proposed work will determine the sensitivity of this method to stream stage variability.

Periodic water samples will also be taken from all the groundwater wells and surface water bodies for isotopic analysis. Water stable isotopes will be determined on a Picarro L2120*i* water isotope analyzer with High-Precision Vaporizer A0211 at the Keck Paleoenvironmental Stable Isotope Laboratory at the University of Kansas.

Study Site Description

The study site is located along a portion of the Arkansas River in south-central Kansas from Larned to Nickerson (Figure 1). Three real-time coupled gages were installed in Larned, Great Bend and Nickerson (Figure 1). This river reach was chosen based on several factors, including having three locations with existing monitoring wells located close to USGS stream gages and significant variations in stream stage within a geographically small location. The river at Larned is generally dry, with flows only after intense precipitation events, The river at Great Bend and Nickerson is perennial with increased flow at Nickerson compared to Great Bend (Figure 2).

2014-2015 Results, Information Transfer and Student Support

Several objectives were met in the first year of this project. Real-time data collection at all three sites was automated for stream stage and groundwater level, and for groundwater temperature at Larned and Nickerson. Limitations on telemetry bandwidth did not allow for groundwater temperature transmission at Great Bend (but it is being logged and manually downloaded), nor has stream temperature been collected. This makes it impossible to perform a temperature-based estimation of gw/sw interactions during the first year of study. However, Onset Tidbits (http://www.onsetcomp.com/products/data-loggers/utbi-001) will be deployed at all three stream locations during the second year to log stream temperature, enabling temperature-based estimations for the remainder of the study period.

Data is transmitted to the USGS via a GOES satellite uplink and the USGS has provided KGS access to this information. An automated data retrieval program was written to access the information and update an internal KGS database for all three sites every 2 hours. This information has yet to be made publicly available via a KGS webpage, however progress has been made in developing the webpages and QA/QC is underway to ensure accurate transmission of measured data to the webpage in advance of their public release. Current versions of the webpages include graphs of stream level, groundwater level and hydraulic gradient in addition to the processed data (example in Figure 3).

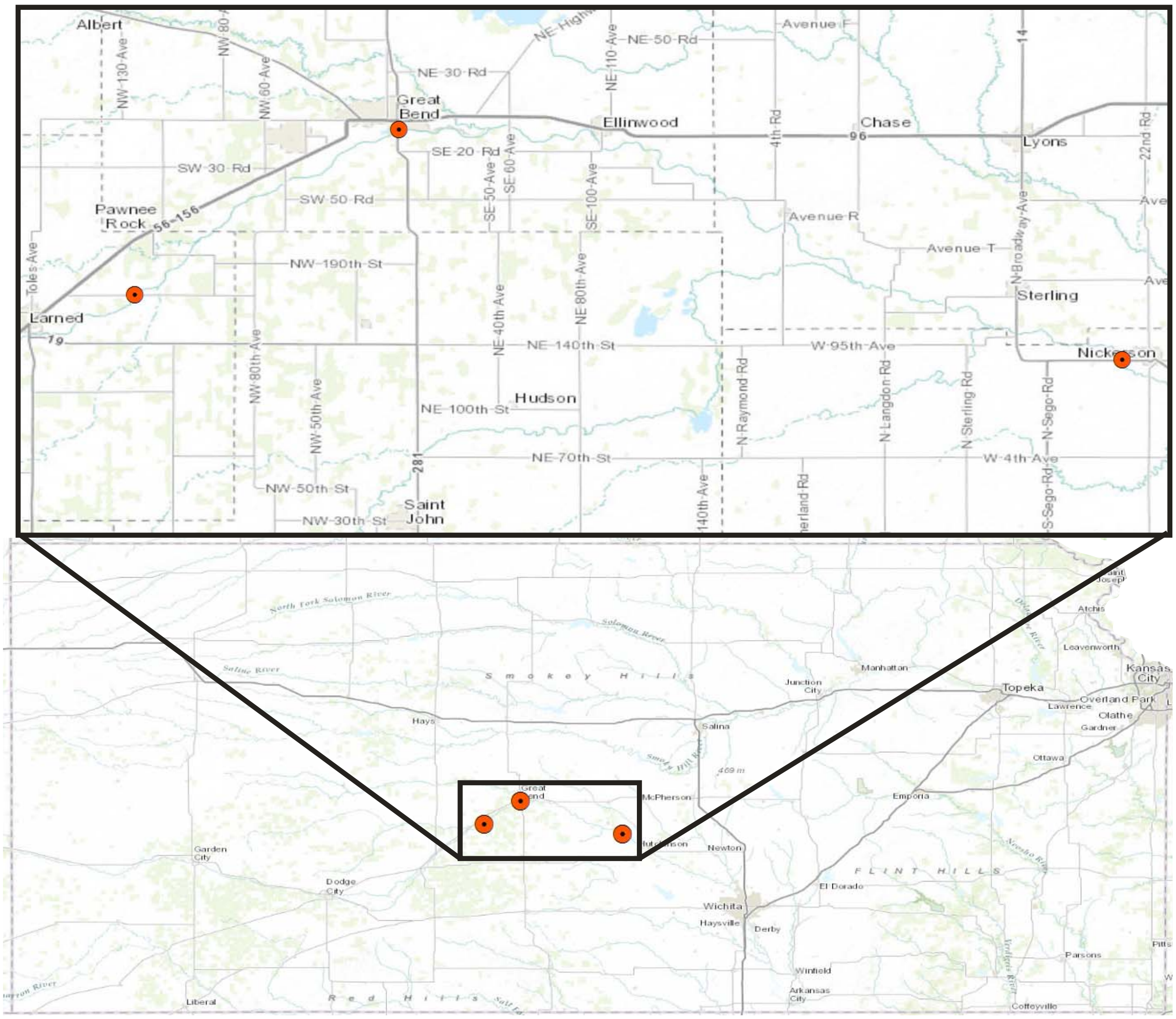


Figure 1 – Location of three USGS gages coupled to existing groundwater wells for this project.

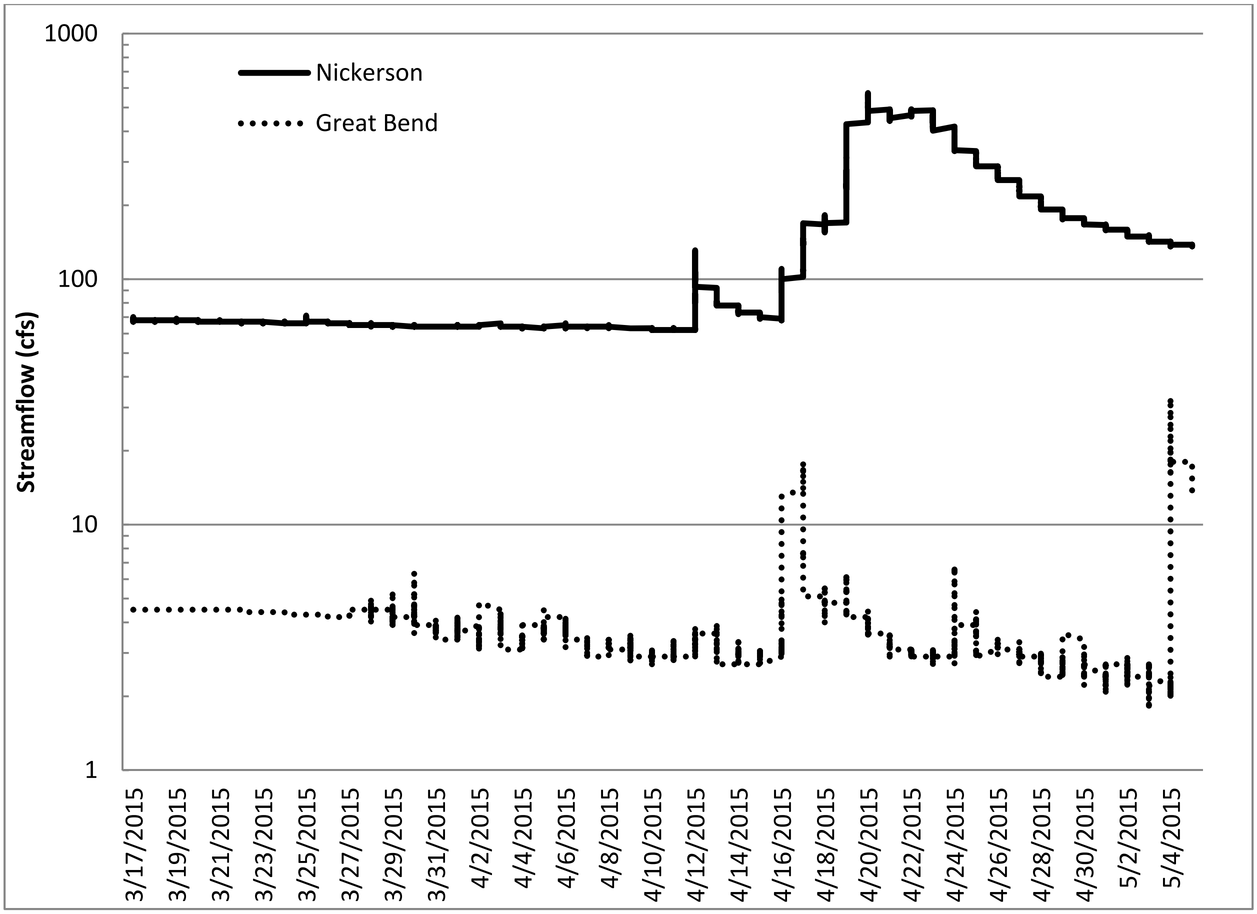
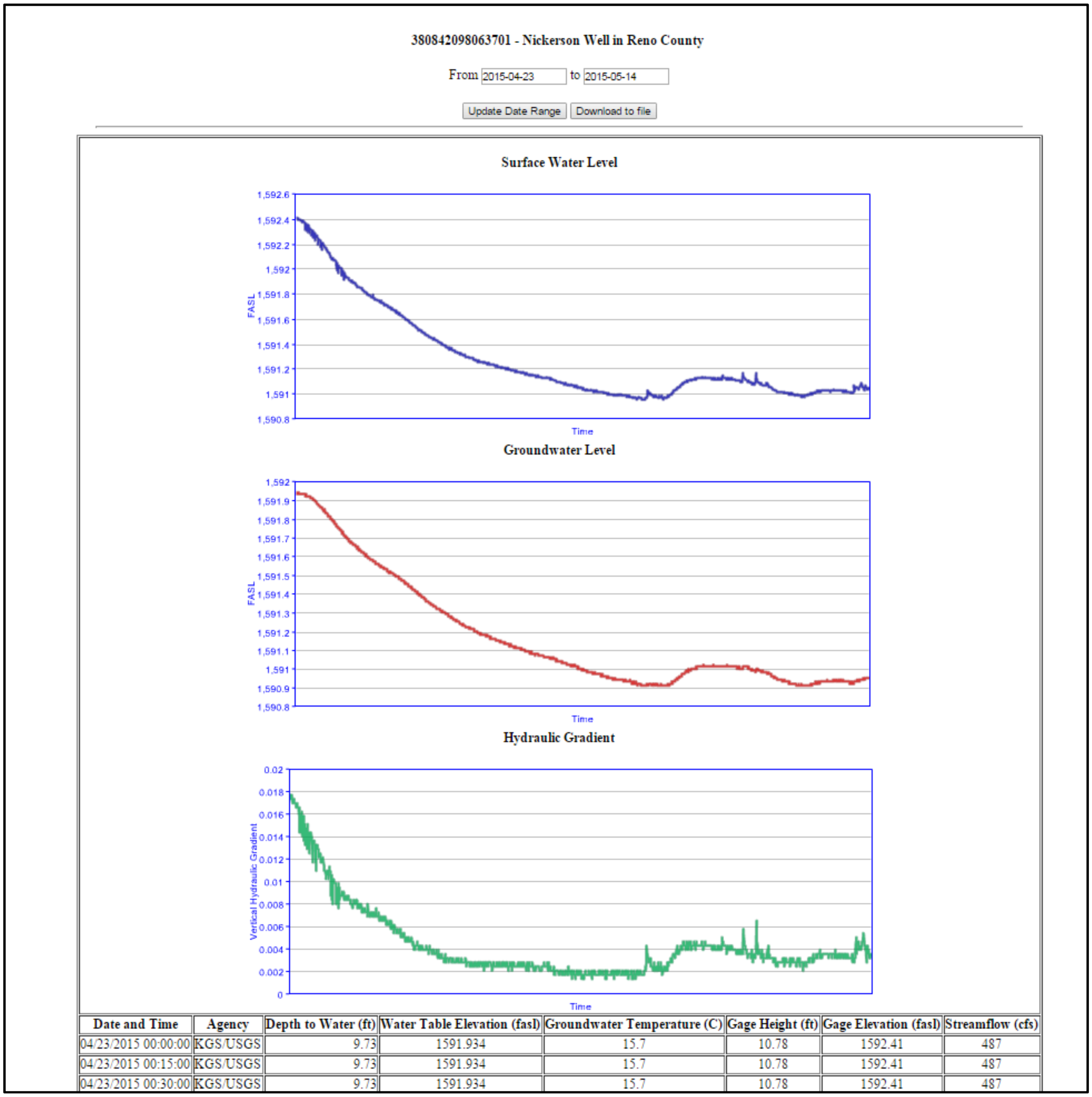


Figure 2 – Streamflow from Nickerson and Great Bend gage stations for 3/17/2015 – 5/4/2015

Analysis of head gradients between the groundwater and surface water levels has provided information on the temporal variability of gw/sw interactions, and their relative magnitude for each site. Dissipation of large hydraulic gradients resulting from precipitation events (and thus increased stream stage) provides some insight into the relative hydraulic conductivities and how they vary temporally and between sites. Development in the second year will include utilizing the Butler and Tsou (2000) approach to estimate the transient hydraulic conductivity based on observed data.



Date and Time	Agency	Depth to Water (ft)	Water Table Elevation (fasl)	Groundwater Temperature (C)	Gage Height (ft)	Gage Elevation (fasl)	Streamflow (cfs)
04/23/2015 00:00:00	KGS/USGS	9.73	1591.934	15.7	10.78	1592.41	487
04/23/2015 00:15:00	KGS/USGS	9.73	1591.934	15.7	10.78	1592.41	487
04/23/2015 00:30:00	KGS/USGS	9.73	1591.934	15.7	10.78	1592.41	487

Figure 3 – Example of webpage for Nickerson coupled gage station data.

River Response Functions (RRF) have been developed and preliminarily analyzed for Great Bend and Nickerson, following the methodology of Spane and Mackley (2011), using a variation of KGS Barometric Response Function software (Bohling et al., 2011). Lack of streamflow at Larned does not allow for RRF analysis at this time. Additionally, Gradient Response Functions (GRF) have been developed for this work to interpret the groundwater response to changes in the hydraulic gradient between the groundwater and surface water. The goal of using GRF is to try to isolate the change in groundwater levels from local flux between the stream and shallow aquifer, as driven by hydraulic gradient, from large-scale changes in groundwater/surface water levels. For example, during a period of no rain both shallow groundwater and surface water may simultaneously decline, with a constant gradient between them, RRF will correlate the change in stream levels with the instantaneous change in groundwater levels, even though the reduction in stream stage is not the driving factor (Figure 4). However, when the stream stage increases due to for example, precipitation, the hydraulic gradient increases and, following Darcy's law, the flux between the groundwater and surface water changes to bring the two systems back into equilibrium (Figure 4). By correlating changes in hydraulic gradient to groundwater level it is anticipated that we can better capture these changes in the local-scale gw/sw interactions. Analysis thus far includes RRF, normalized RRF, Gradient Response Functions (GRF;, as developed in this work) and normalized GRF.

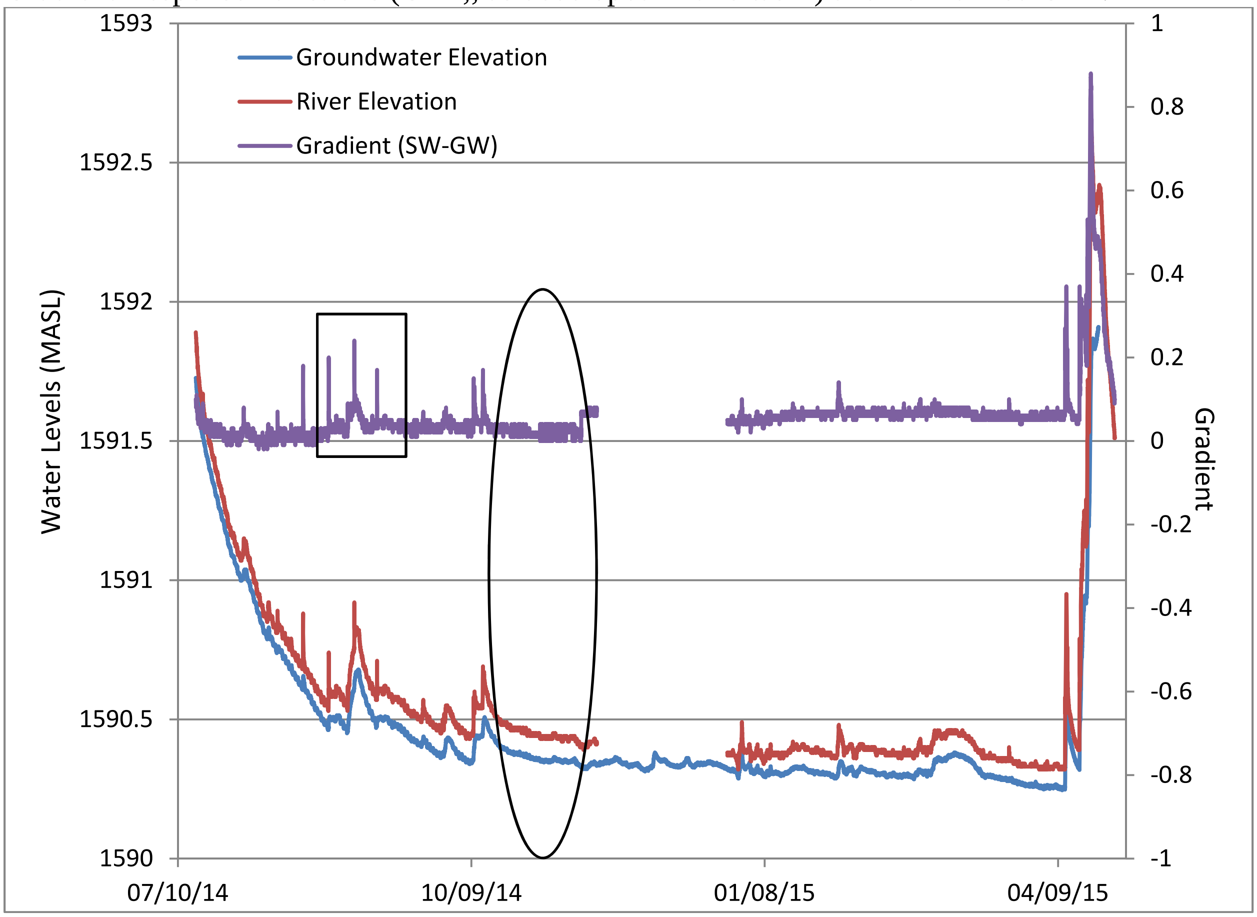


Figure 4 – Water levels and gradient for Nickerson site. Circled area indicates an example of a simultaneous change in groundwater and surface water due to a long-term/large-scale influence with no significant change in gradient, whereas the area outlined in a square indicate peaks in the gradient where a short-term/local change influences the flux between groundwater and surface water.

Each response function (RF) was developed with 150 lag intervals of 15 minutes per lags (approximately 1.5 days total) for the entire current period of record (August 2014 – April 2015), 60 day intervals (consistent with Spane and Mackley (2011) methodology), and 30 day intervals. While the RFs for the entire period of record provide an average trend, the 60 and 30 day intervals can indicate temporal variability in groundwater response to changes in stream stage/hydraulic gradient. The original RFs can be used to assess hydraulic characteristics of the aquifer, and the normalized RFs can provide a qualitative means for evaluating general areal aquifer properties (transmissivity and storage) over the respective well/river distance, and can also be used to assess the nature of the aquifer/river boundary (Spane and Mackley, 2011).

Analysis of the response functions developed for Nickerson and Great Bend has just begun. Initial analyses indicate that that the RFs for Great Bend have more temporal variability than Nickerson (Figures 5 & 6) and are indicative of another source of groundwater to the local system. More detailed analysis to determine the reasons behind these differences is part of the work to be done in year 2.

One round of isotope sampling and analyses has been conducted (Table 1). These results are consistent with the initial RF analysis in that the relationship between groundwater and surface water between Nickerson and Great Bend are different. These results support the hypothesis that groundwater at Great Bend is influenced by another source of water, as the isotopic signature for groundwater at Great Bend is significantly different than the other groundwater and river water samples. Two more rounds of isotope sampling and analysis will be completed in year 2 to investigate any temporal differences in isotopic signatures. Attempts will be made to sample surface ponds in the vicinity of the Great Bend groundwater well to determine they are a source of recharge to the local groundwater.

One Master's student received summer funding as part of this work, and was trained in geochemical sampling, sensor installation, isotopic analysis and river response functions. Another master's student will be funded during summer 2015 to perform further geochemical sampling, analyze temporal trends in river response functions, and update and manage the webpages. The results of the first year of this project will be presented at the NovCare conference (http://www.ufz.de/novcare/) in Lawrence, KS on May 19, 2015.

Table 1 - d^{18}O and d^{2}H analysis results

	δ^{18}O V_{SMOW} (‰)	δ^{2}H V_{SMOW} (‰)
Learned Groundwater	-6.61	-46.4
Great Bend Arkansas River Water	-6.03	-44.4
Great Bend Groundwater	1.22	-5.3
Nickerson Arkansas River Water	-5.30	-37.2
Nickerson Groundwater	-6.66	-43.5

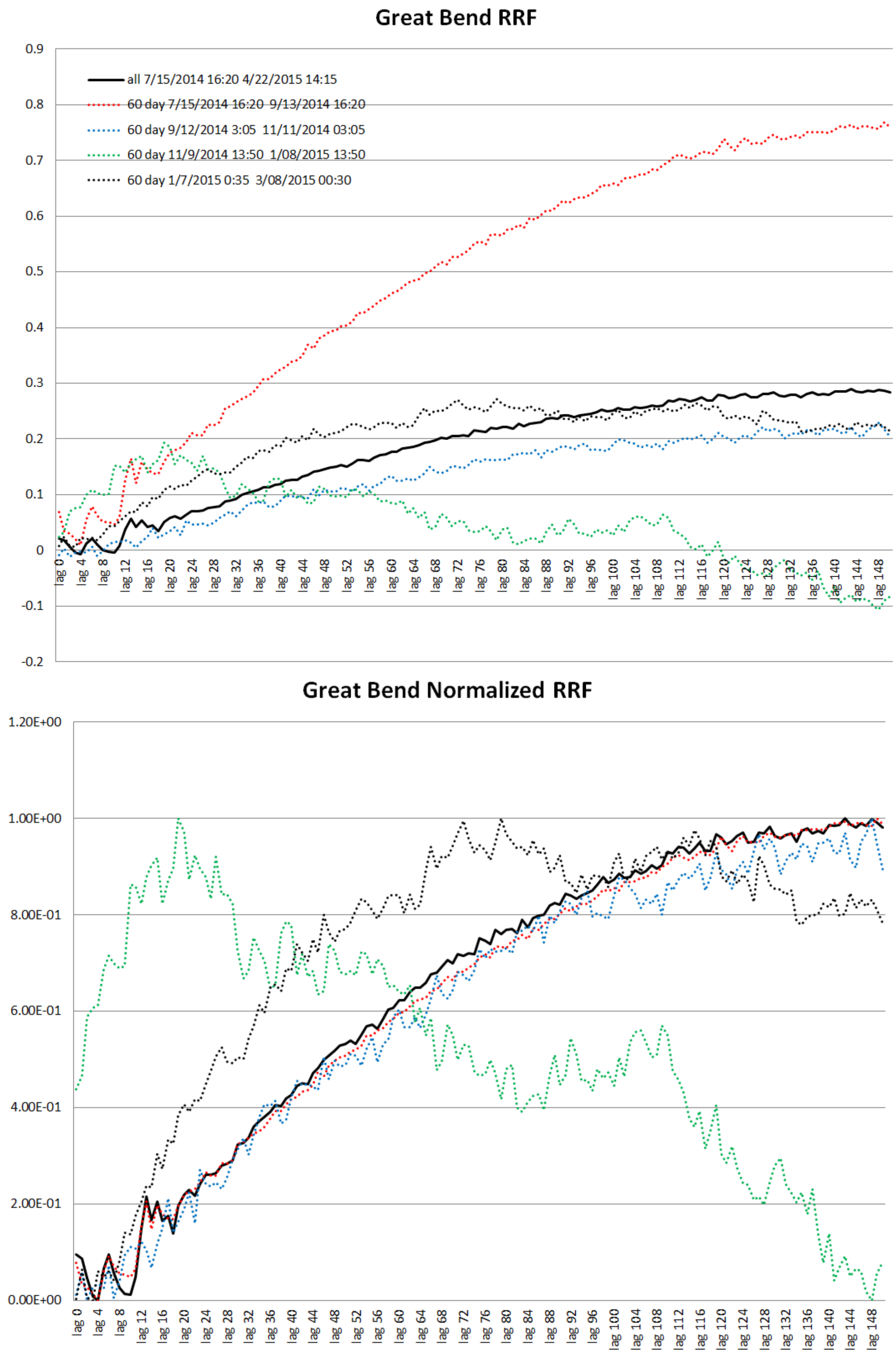
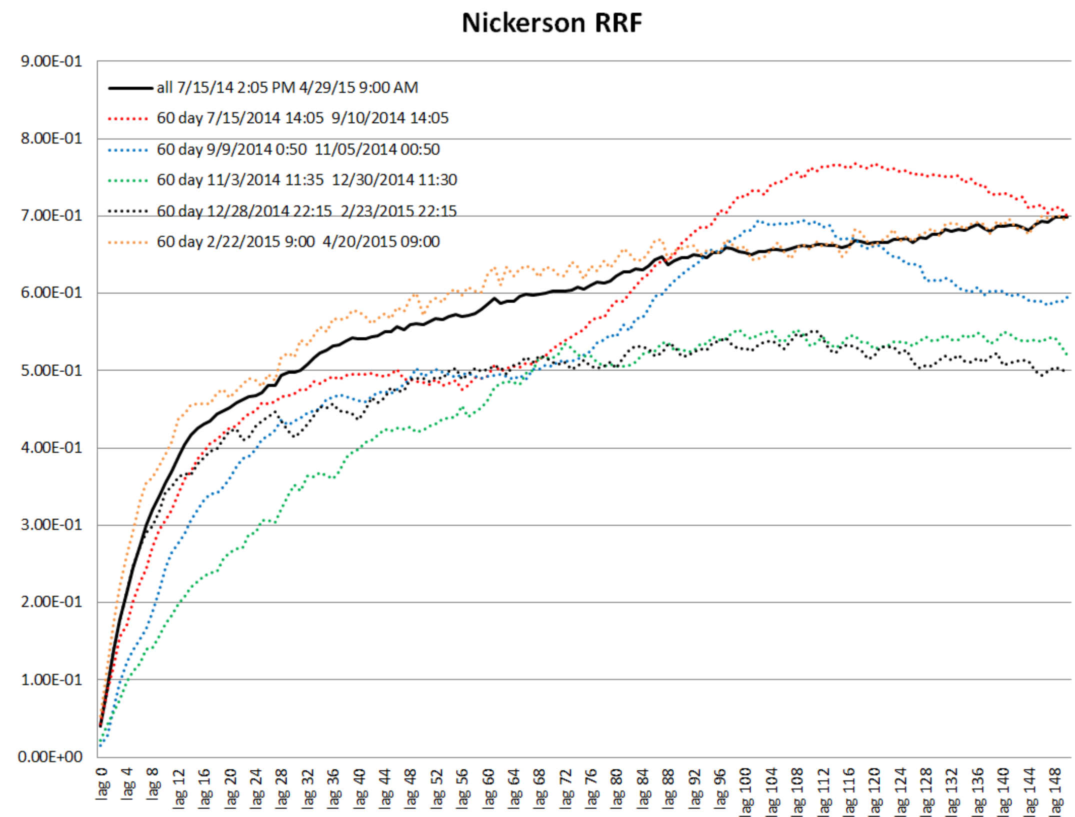


Figure 5 – River Response Functions for Great Bend for entire period of record and 60 day intervals.



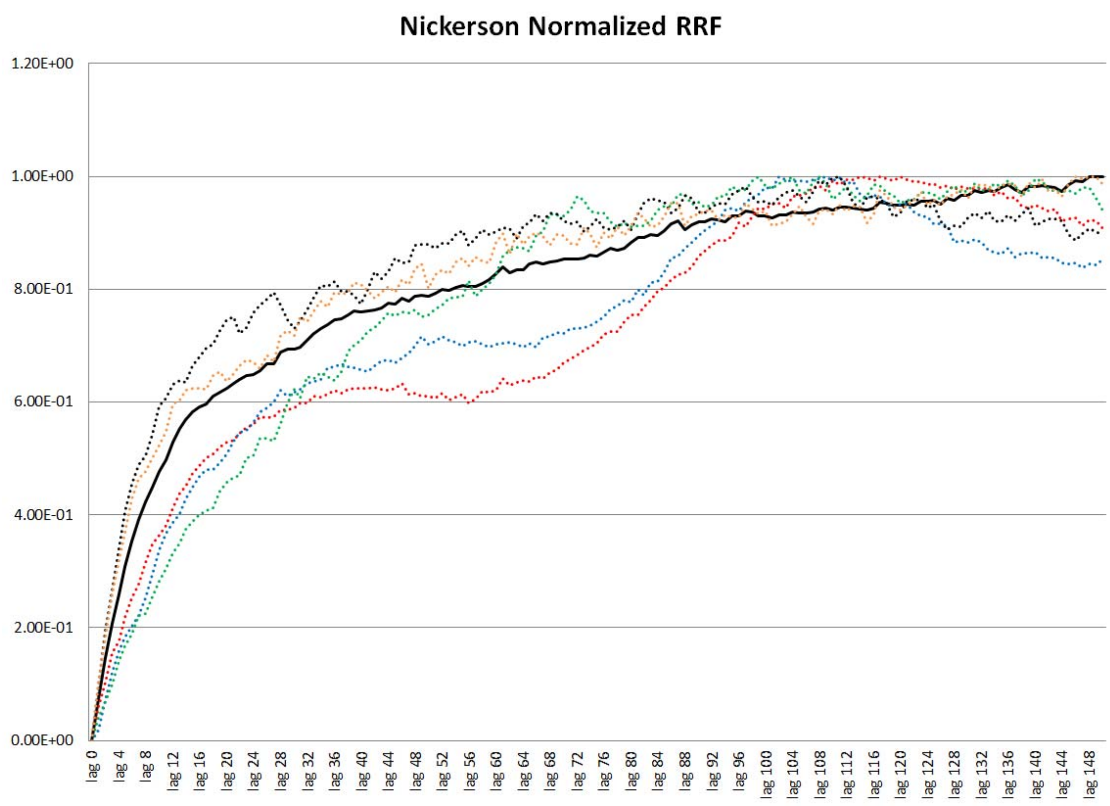


Figure 6 –River Response Functions for Nickerson for entire period of record and 60 day intervals.

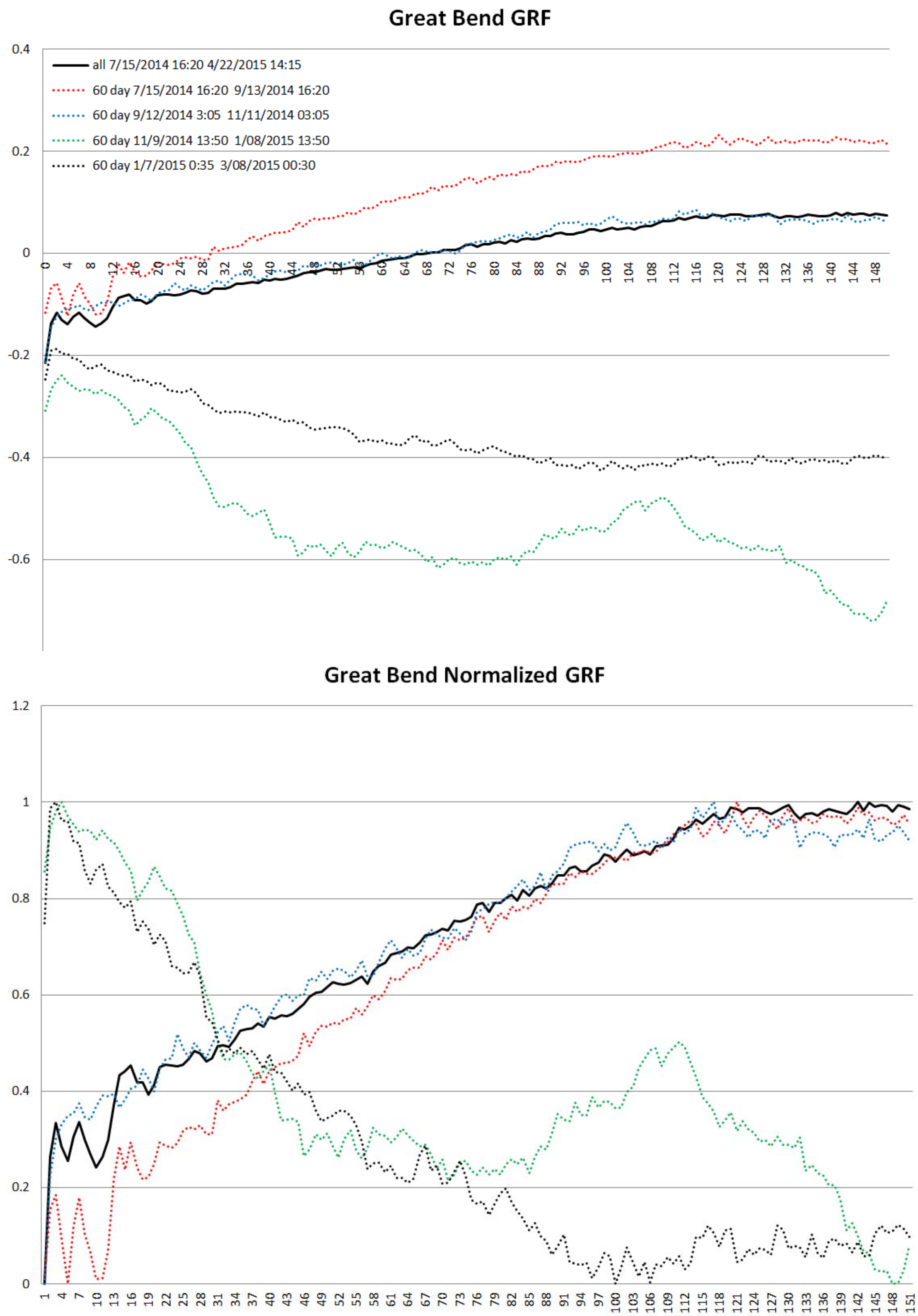


Figure 7 – Gradient Response Functions for Great Bend for entire period of record and 60 day intervals.

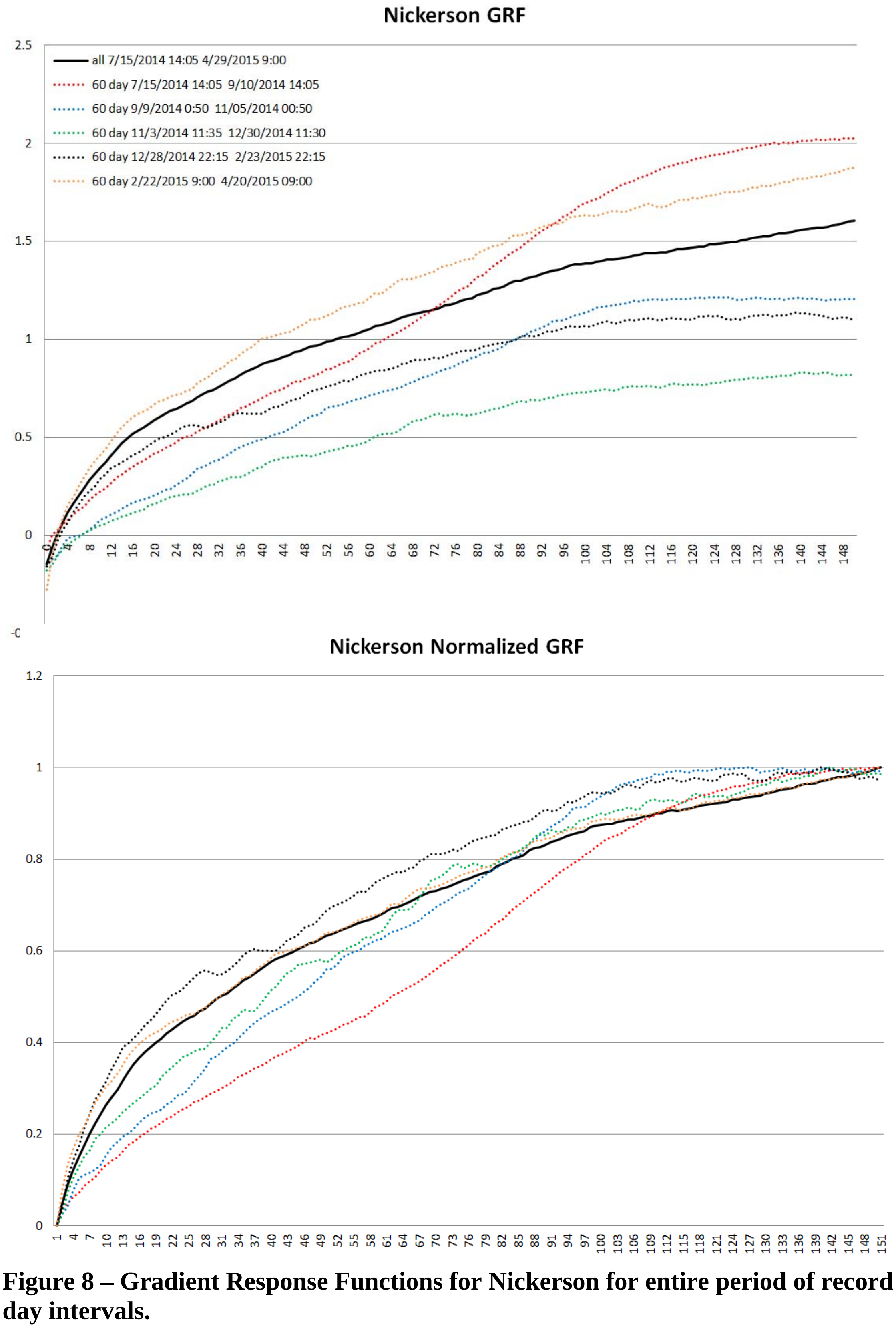


Figure 8 – Gradient Response Functions for Nickerson for entire period of record and 60 day intervals.

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Fate of High Uranium in Saline Arkansas River Water in Southwest Kansas: Distribution in Soils, Crops, and Groundwater

Basic Information

Title:	Fate of High Uranium in Saline Arkansas River Water in Southwest Kansas: Distribution in Soils, Crops, and Groundwater
Project Number:	2014KS174B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-002
Research Category:	Ground-water Flow and Transport
Focus Category:	Toxic Substances, None, None
Descriptors:	None
Principal Investigators:	Donald Whittemore, Jonathan P Aguilar, Gwen Macpherson

Publications

There are no publications.

Progress Report for
Kansas Water Resources Institute Project

FATE OF HIGH URANIUM IN SALINE ARKANSAS RIVER WATER IN SOUTHWEST KANSAS: DISTRIBUTION IN SOILS, CROPS, AND GROUNDWATER

May 15, 2015

PI, Donald O. Whittemore, Kansas Geological Survey, University of Kansas, donwhitt@kgs.ku.edu, 785-864-2182
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Co-PI, Jonathan Aguilar, Southwest Area Office, Kansas State University, Research and Extension, jaguilar@ksu.edu, 620-275-9164
Key personnel, Masato Ueshima, Department of Geology and Kansas Geological Survey, University of Kansas, mueshima@ku.edu, 785-864-1934

Project Goals and Objectives:

Goal: Determine the fate of high uranium concentration dissolved in saline Arkansas River water that is used for irrigation in the upper Arkansas River corridor in Kearny and Finney counties, southwest Kansas. The results from this project will be valuable for assessing whether high concentrations of uranium in irrigation water in the study area and other areas of the U.S., such as the South Platte River in northeast Colorado and southwest Nebraska, could be preferentially concentrated in soils and crops.

Objectives:

1. Determine concentration of uranium in representative soils and crops, and in river water and groundwater within the area where Arkansas River water is diverted for irrigation in Kearny and Finney counties. The main question to be answered is whether the uranium dissolved in the river water is being preferentially accumulated in soils and/or bioaccumulated in parts of crop plants or remains in irrigation return flow and is primarily leached to the groundwater.

2. Provide data that can be used for a more comprehensive proposal for greater funding to determine more specifically the fate and distribution of the uranium, especially if the results indicate accumulation in soils and crops.

Study Activities:

Coordination with Southwest Kansas Groundwater Management District No. 3 (GMD3)

The study was discussed with the manager of GMD3 who agreed to assist in aspects of the study. This proved to be critical to finding irrigators willing to have their irrigation wells, soils, and crops sampled and analyzed, considering that the focus of the study on uranium is a potentially sensitive issue. The agreement is that the specific locations of the soil, crop, and irrigation well sampling sites on privately owned farms will not be reported but that the data locations will be indicated by the general study area. One of the six field locations is on the research land of the Southwest Research–Extension Center (SWREC) of Kansas State University at Garden City where one of the co-PIs on the study works. Thus, except for the Arkansas River water samples and the SWREC field and irrigation well, the county location is the smallest resolution that will be reported for location data. The sites sampled in 2014 are all in the study area as described in the proposal: the portion of the Arkansas River in Kearny County where irrigation water has historically been and is currently diverted for irrigation, and the Arkansas River corridor in Kearny and Finney counties where crop fields have been historically and recently irrigated with the diverted river water and groundwater impacted by past seepage of diverted irrigation water.

An attempt was made by GMD3 in conjunction with the KWRI study to find a part time summer student who could assist in both GMD3 and KWRI study activities. This approach did not work out for GMD3 and the study. However, the Kansas State University co-PI and GMD3 staff were able to sample the sites and media needed for the first year of the study.

Description of Investigations:

1. Sampling during 2014: The sampling design involved collecting samples of input irrigation water, soils, and plants from six selected irrigated fields where different crops are grown. The design provides for determining uranium and major constituent concentrations in both river water and groundwater, in soils at two depths and in two modes of occurrence of plant-available uranium from the soils, and in the grain or primary plant part for livestock or human consumption, secondary plant parts for livestock consumption, and the roots.

a. Input waters (eight samples, Table 1): Three samples of Arkansas River water were collected at the headgate of the Amazon ditch in southwest Kearny County during the summer of 2014 when river water was diverted via the canal and distribution ditches to irrigate crops. This was during the period when Kansas called for water from Colorado such that ongoing summer releases from John Martin Reservoir in southeastern Colorado were allowed to reach Kansas in substantial quantity rather than being greatly reduced by diversion for irrigation downstream of the reservoir in Colorado. Groundwater samples were collected from five wells associated with the crop fields from which soil and plant samples were obtained.

b. Soils (12 samples; Table 3): Soil samples were collected at multiple locations and at two different depths (top 1 m and from 1-2 m) at each of the six fields. The soils from each field and depth were sampled using a coring device and transported and stored in soil sample bags. The samples from the different locations from the same depth in a field were composited.

Table 1. Information for river water and groundwater samples collected from the study area in 2014.

KGS lab number	Sample site name	Sample source	County	Sample date	Sample time	River flow at Kendall, ft^3/sec
2014113	Amazon Ditch headgate	Arkansas River	KE	7/15/14	-	235
2014114	Amazon Ditch headgate	Arkansas River	KE	7/25/14	15:45	241
2014115	Amazon Ditch headgate	Arkansas River	KE	8/7/14	11:45	354
2014116	C1 Corn field well	Irrigation well water	FI[a]	10/7/14	16:00	
2014117	C2 Corn field well	Irrigation well water	KE	9/8/14	11:00	
2014118	S1 Soybeans field well	Irrigation well water	FI	9/4/14	10:00	
2014119	A Alfalfa field well	Irrigation well water	KE	9/10/14	15:45	
2014120	M Milo field well	Irrigation well water	FI	10/22/14	17:00	

[a] Field at Southwest Research–Extension Center, KSU, Garden City

Table 2. Chemical data for river water and groundwater samples collected from the study area in 2014.

KGS lab number	Spec. cond., lab[a] µS/cm	pH, lab	SiO_2 mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Sr mg/L	B mg/L	HCO_3 mg/L	Cl mg/L	SO_4 mg/L	NO_3-N mg/L	F mg/L	Br mg/L	U µg/L	TDS[b] mg/L
2014113	1092	7.67	9.64	96.5	34.7	84.9	12.3	1.49	0.15	163	29.4	389	1.41	0.53	0.13	12.0	736
2014114	1625	7.77	10.8	138	60.2	149	8.70	2.41	0.24	207	45.3	686	0.21	0.70	0.23	19.1	1,194
2014115	2006	7.90	12.6	176	77.6	192	9.11	3.06	0.31	216	57.6	885	0.23	0.78	0.32	24.5	1,509
2014116	3642	7.27	33.7	451	209	261	12.3	10.6	0.21	290	199.1	1,813	5.33	0.50	1.11	82.7	3,124
2014117	1989	7.84	25.7	295	70.1	83.3	8.15	3.92	0.15	201	101.5	854	5.58	0.32	0.68	26.6	1,540
2014118	2774	7.68	26.7	269	135	223	9.45	7.03	0.17	210	159.1	1,239	9.91	0.67	1.04	40.1	2,191
2014119	3585	7.29	29.5	371	185	363	13.6	10.2	0.40	343	128.6	1,818	0.72	0.55	0.85	102	3,063
2014120	2407	7.55	28.5	298	119	118	9.34	6.44	0.20	197	140.9	1,080	6.89	0.53	0.95	29.5	1,902

[a] Specific conductance at 25 ºC
[b] Total dissolved solids

Table 3. Information for soil and crop plant samples collected from the study area in 2014.

Field crop	Sample code	County	Soil sample (number of composite sample locations)		Soil sample date	Biomass sample (number of plants)			Biomass sample date
			1-2 ft depth	3-4 ft depth		Grain	Above ground non-grain	Roots	
Corn	C1	FI[a]	2	2	10/7/2014	4	4	4	10/7/2014
Corn	C2	KE	3	3	9/29/2014	4	4	4	9/29/2014
Soybean	S1	FI	4	0	9/25/2014	4	4	4	9/25/2014
Soybean	S2	KE	4	0	9/25/2014	4	4	4	9/25/2014
Milo	M	FI	2	1	9/26/2014	4	4	4	9/26/2014, 10/7/2014
Alfalfa	A	KE	1	1	9/26/2014	1	1	1	9/26/2014

[a] Field at Southwest Research–Extension Center, KSU, Garden City

c. Plants (34 samples after division into plant parts – grain (or all above ground plant for alfalfa), non-grain biomass above ground, and roots; Table 3): Two fields each of corn and soy beans and one field each of sorghum and alfalfa were sampled. Two separate areas of each crop field were sampled when the plants were mature. Complete plants of corn, soy beans, and sorghum, and alfalfa were collected at different locations (except for alfalfa, which was collected at one location) in each of the six fields and composited, transported, and stored in large cloth plant sample bags that allow air drying of the sample. The corn and milo plants were divided into above ground (grain, stalk, leaves, cob/husk) and below ground (roots) plant parts in the field and placed in separate sample bags. The soybean and alfalfa plants were placed in the sample bags as complete above and below ground parts.

c. Plants (34 samples): Two fields each of corn and soy beans and one field each of sorghum and alfalfa were sampled. Two separate areas of each crop field were sampled. Mature plants were sampled after the plant ceased to grow. Four different complete plants of corn, soy beans, and sorghum and eight plants of alfalfa were collected at different locations in each of the different areas of the six fields, divided into plant parts, and then composited. The roots of all plants are one part (12 samples). The grain of corn (kernels), soy beans (beans), and sorghum (seeds) comprise a second part for these crops (10 samples). The rest of the corn, soy bean, and sorghum plants are the third part of these crops and include the stalk and leaves as well as the cob and husk for corn and the pods for soy beans (10 samples). The entire above ground part of alfalfa plants is analyzed as a unit (2 samples).

4. Procedures for preparing samples for analysis:

a. Waters (eight samples): Water samples are filtered through 0.45 µm membrane filters. Aliquots for cation and uranium determination are acidified with nitric acid.

b. Soils (24 sample solutions prepared from the 12 samples): Soil samples are allowed to completely dry at laboratory room temperature. Approximately 100 g of the samples are disaggregated with a mortar and pestle, passed through a 2 mm mesh sieve, placed in a heavy paper sample container with lid, and allowed to further air dry. Two 10 g portions are weighted and each placed in two 250 mL glass Erlenmeyer flasks with glass stoppers. To one 10 g portion is added 100 mL of high purity deionized water; to the other portion is added 100 mL of 1.58 N nitric acid (1:10 dilution of concentrated nitric acid). The deionized water and nitric acid in each of the flasks is allowed to leach the soil for two days; during several hours on each of the two days, a sample shaker is used to agitate the soil and solution. Over 40 mL of each leach solution is poured from the flask into a plastic centrifuge tube and centrifuged. Approximately 37 mL of the supernatant solution from each centrifuge tube with deionized water leachate is extracted and filtered through a 0.45 µm membrane filter. A pipet is used to extract 30 mL of each filtered solution into a plastic tube and 0.6 mL of concentrated nitric acid is then added. Exactly 10 mL of the supernatant solution from each centrifuge tube with a nitric acid leachate is pipetted into a 50 mL glass volumetric flask and diluted to the mark with high purity deionized water. Each of the 24 sample solutions is divided into two portions, one for cation concentration determination and the other for uranium concentration measurement. The high purity deionized water extract represents the water soluble fraction of the soil and the acid leach represents that fraction containing carbonate minerals and readily soluble iron and manganese oxyhydroxides to which uranium could be chemically bound.

c. Plants (34 samples): Above ground samples of corn and milo are divided into grain (kernels, seeds) and non-grain plant portions. Complete plant samples of soybeans are divided into soybeans, non-bean above ground plant parts, and root portions. The complete plant sample of alfalfa is divided into above ground and root portions. Soil is removed from the plants and the plant portions rinsed with deionized water to remove remaining soil and dust, and the biomass samples are allowed to dry. Approximately 100 g representing each biomass sample is ground using a grain mill to a consistency of flour, passed through a 1 mm sieve, mixed, and placed in a heavy paper sample container. The samples are then dried overnight at 85 ºC before digestion. Procedure No. 1 in the nitric acid digestion method for analyzing plant material by Zarcinas et al. (1987) is used. One gram of plant sample is added to a glass tube made to fit a block digestor with temperature controller (Techne Model DG-1); 10 mL of concentrated nitric is then added to the tube and allowed to stand overnight at room temperature. The tube is first heated for 4 hr at 120 ºC in the block digestor followed by heating at 140 ºC until about 1 mL of acid solution remains. After cooling to room temperature, 50 mL of high purity deionized water is pipetted into the tube. Each of the 34 sample solutions is divided into two portions, one for cation concentration determination and the other for uranium concentration measurement.

5. Analysis of waters and solutions:

a. An automated titrimeter is used to determine the alkalinity (bicarbonate) concentration of river and groundwater samples.

b. Ion chromatography is used to determine the concentrations of anions (sulfate, chloride, nitrate, fluoride, and bromide) in river and groundwater samples and distilled water leachates of soils.

c. Inductively coupled plasma-optical emission spectroscopy is used to determine the concentrations of cations (calcium, magnesium, sodium, potassium, strontium) in the acidified portion (nitric acid) of all water samples, soil leachates, and plant digests.

d. Inductively coupled plasma-mass spectrometry is used to determine the concentration of uranium in the acidified portion (nitric acid) of all water samples, soil leachates, and plant digests.

Results:

The river water and groundwater samples have been analyzed for cation, anion, and uranium concentrations. The soil and plant samples are currently being processed and prepared for analysis for analysis so that the analyses will be for a complete set of soil leachates and then for all plant digests.

Sample information and chemical data for the river water and groundwater samples are in Tables 1 and 2, respectively. All of the waters are saline (greater than 1,000 mg/L total dissolved solids) except for the first sample of Arkansas River water. The constituent in greatest concentration in all of the water samples is sulfate. All sulfate concentrations exceed the recommended level of 250 mg/L for public consumption of drinking water; the values ranged from 389 to 1,239 mg/L. The uranium concentration range in the river waters is 12–24.5 µg/L. This is substantially lower than in low flows of the river, which usually contain a uranium concentration that appreciably exceeds the maximum contaminant level (MCL) of 30 µg/L for public consumption of drinking water (Whittemore and Petroske, 2011). Nitrate-N concentration is low in the Arkansas River water samples as observed for the river during the last couple of decades.

The uranium concentration range is 26.6–102 µg/L for the groundwaters sampled from irrigation wells; uranium in three of the groundwaters substantially exceeds the MCL. The uranium concentration of 102 µg/L is the highest yet observed for groundwaters in the Arkansas River corridor in southwest Kansas. None of the irrigation well waters contained nitrate-N above the MCL of 10 mg/L, although one well water sample was very close to the MCL.

The uranium concentration in the river and groundwater samples collected in 2014 for this study are generally well correlated with the sulfate concentration (Figure 1). Points for the samples of Arkansas River water at the Amazon headgate are close to the linear regression (and its extension to lower sulfate concentration if plotted in Figure 1) for river waters collected during 2009-2012 (Whittemore and Petroske, 2011; Whittemore, unpublished; Kansas Department of Health and Environment stream monitoring program). Two of the 2014 river water samples have lower sulfate and uranium concentrations than any of the 2009-2012 samples, reflecting dilution of Arkansas River water by substantial rainfall runoff that occurred in July during the period when releases from John Martin Reservoir were allowed to pass through to Kansas. Points for three of the irrigation well water samples collected in 2014 plot near the regression line for Arkansas River water. Points for the other two well waters lie substantially above the regression line for the Arkansas River as do points for samples from wells in the City of Lakin municipal wellfield in Kearny County. This indicates either a relatively high background concentration of uranium in the High Plains aquifer, concentration of uranium relative to sulfate levels in the return flow below irrigated fields (such as could be caused by a decrease in sulfate concentration by precipitation of gypsum in the soil), or both causes.

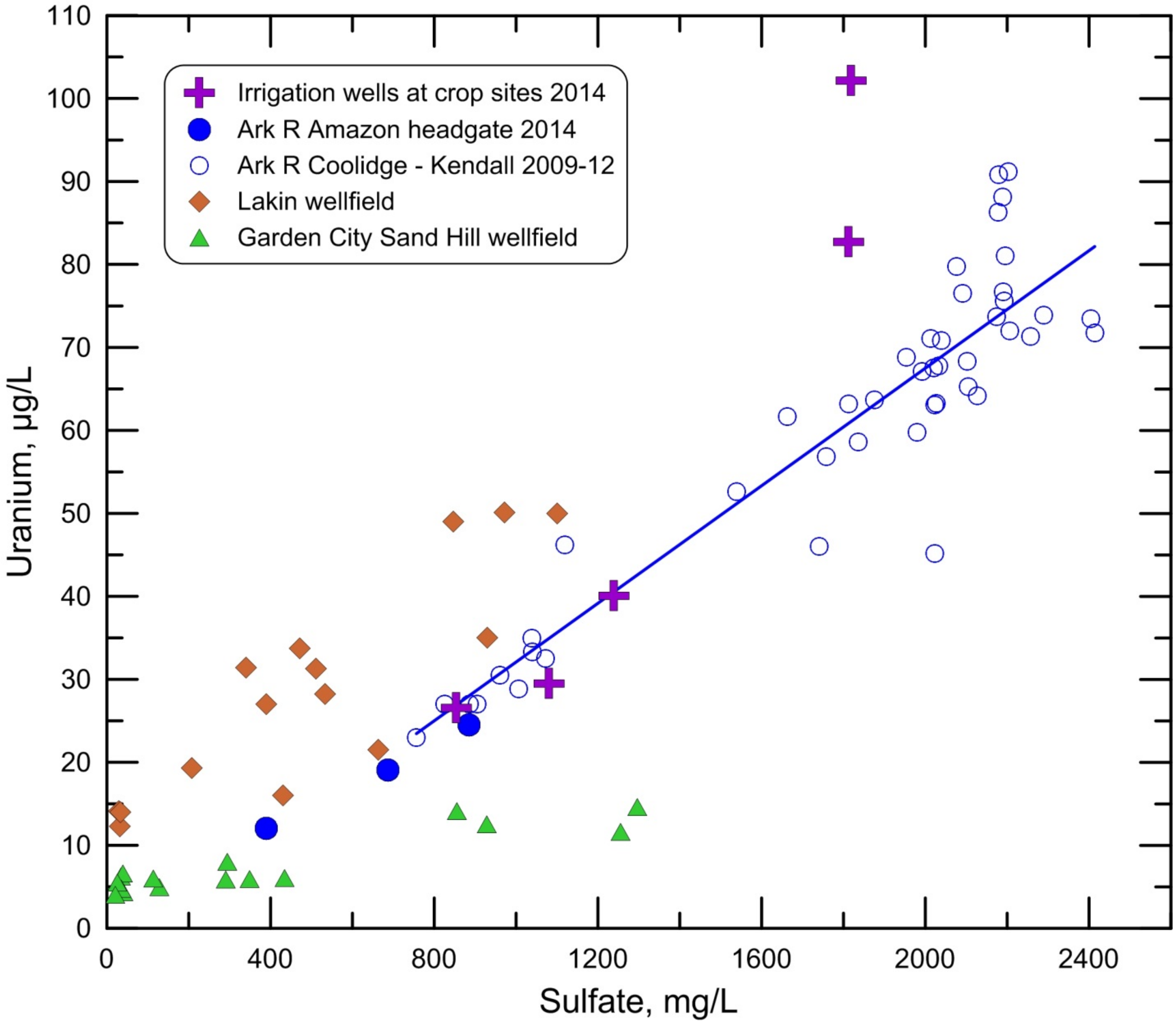

Figure 1. Uranium versus sulfate concentration for Arkansas River water collected from Coolidge to the Amazon headgate and for groundwater collected from municipal wells in the City of Lakin wellfield in Kearny County and the City of Garden City Sand Hill wellfield in Finney County.

The study procedures described in the grant proposal indicate that the degree of concentration in different sample media will be compared using the ratio of uranium to total cation concentration. The total cation concentration is used instead of sulfate for the ratio because sulfate is difficult to determine in the acid extracts of the soil samples and digests of the plant samples, whereas cations can easily be measured in the diluted acid solutions by inductively coupled plasma spectrophotometry. The uranium/total cation mole ratio (where total cations include calcium, magnesium, sodium, and potassium concentrations) is plotted versus sulfate concentration in Figure 2 to determine the range in the ratio for river waters and groundwaters of different salinity in the study area. The ratio is relatively constant with salinity (as represented by sulfate concentration) in Arkansas River waters. Groundwaters from municipal wells in Kearny County generally have uranium/cation ratios near or above the ratio for Arkansas River waters, whereas groundwaters from municipal wells in Finney County have ratios near or below the ratio for the Arkansas River. The uranium/cation ratio for three of the irrigation wells at the fields sampled for soils and crop plants in the study area are similar to the ratio for Arkansas River water, whereas the other two have a ratio greater than for the river.

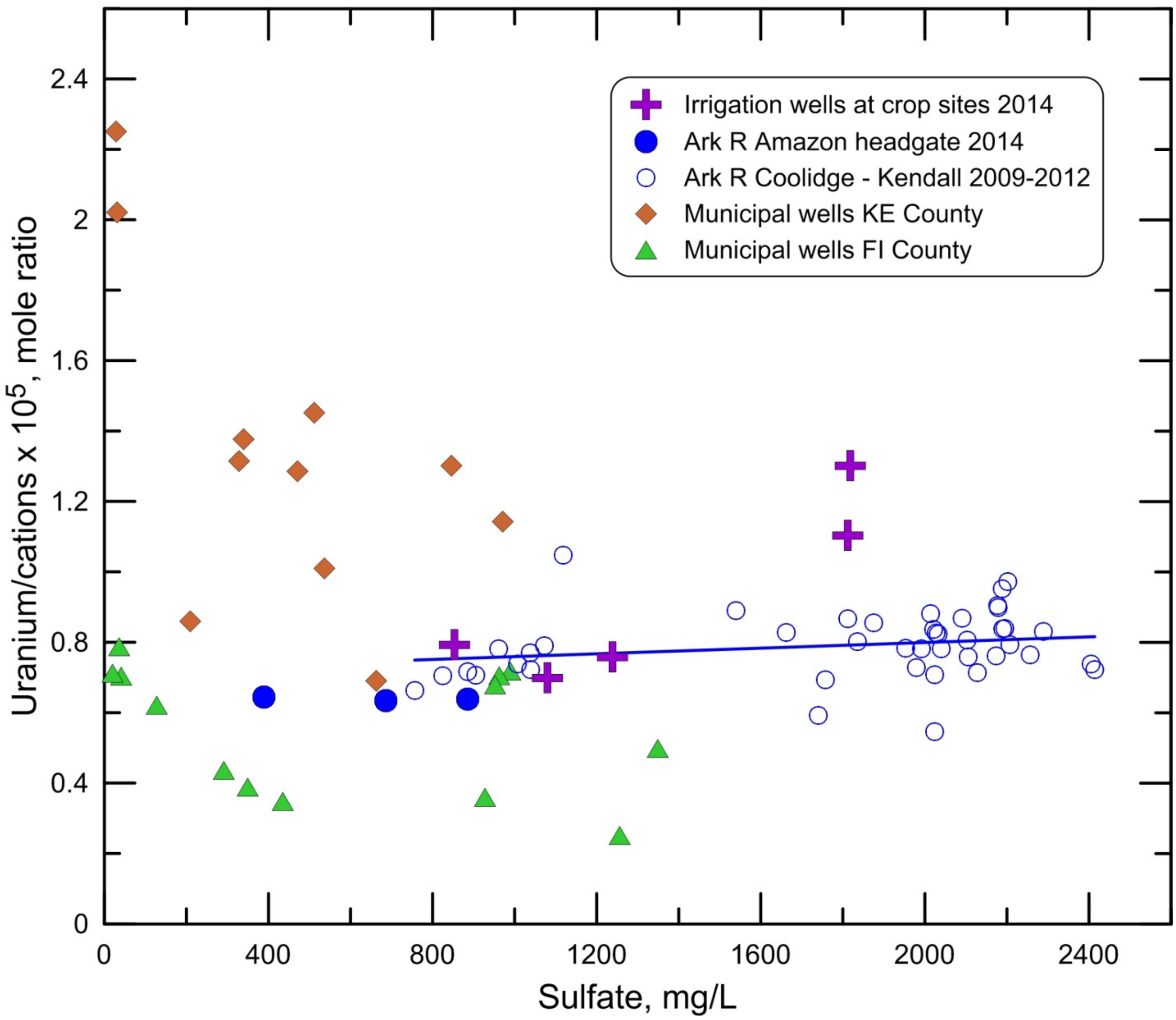

Figure 2. Mole ratio of uranium to total cations versus sulfate concentration for Arkansas River water collected from Coolidge to the Amazon headgate and for groundwater collected from municipal wells in Kearny County and Finney counties.

The study proposal procedures also indicate that uranium loads from diverted Arkansas River water will be estimated for the study area. Irrigation ditch companies in southwest Kansas called for Arkansas River water from Colorado to be allowed to enter Kansas in substantial quantity (above low flows and great enough for diversion in Kansas canals) from early July to early August in 2014. No flow occurred in the Arkansas River at Deerfield (eastern Kearny County) during this period except for July 30 when flow averaged less than 0.5 ft^3 for that day that was caused by a rainstorm (USGS flow records, http://waterdata.usgs.gov/ks/nwis/current/?type=flow). Thus, all of the flow from Colorado that entered Kansas during early July to early August either seeped into the alluvial and High Plains aquifers underlying the riverbed or was diverted for irrigation. The estimated uranium load that either infiltrated into the subsurface, remained in soils, or that was taken up by crops during the period was approximately 400–500 kg, which is equivalent to about 11,000–14,000 acre-ft of water with a uranium concentration of 30 µg/L, the MCL for uranium in public supplies of drinking water.

Future Work

Preparation for and analysis of soil and plant samples collected in 2014 will be completed. The second round of river, groundwater, soil, and plant samples will be collected during the late summer/early fall of 2015, and then processed and analyzed in the fall to the end of 2015. The data will be analyzed as described in the proposal to include determining the degree of concentration of uranium in different sample media, estimating the uranium loads to the land surface, and estimating the fate of uranium from river diversions. Data and interpretation from the 2014 set of water, soil, and plant samples and the 2015 set of water samples will be used for a presentation at the Governor's Conference on the Future of Water in Kansas in Manhattan, November 18-19, 2015. A paper will be prepared for publication in a peer-reviewed journal that reports the results, conclusions, and implications. The results and interpretation will be used to determine the type of data most needed for future research to assess the fate, transport, and impact of high-uranium river water in southwest Kansas, which will be proposed to other funding programs and agencies.

As described earlier, the attempt made to find a part time summer student who could assist in the sampling activities in the study area did not work out during 2014 and turned out to not be necessary. The approach for student involvement now being investigated is to support part of the time of a student at KU for participation in sample preparation and analysis, as well as educational aspects associated with a visit to the study area, including the KSU Southwest Research–Extension Center next to Garden City, with the PI and exposure to the data analysis and interpretation by the PI and co-PIs.

References

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Zarcinas, B.A., Cartwright, B, and Spouncer, L.R., 1987, Nitric acid digestion and multi-element analysis of plant material by inductively coupled plasma spectrometry. Communications Soil Science Plant Analysis 18(1), 131-146, **DOI:** 10.1080/00103628709367806.

Information Transfer Program Introduction

The KWRI is committed to transferring knowledge generated by its researchers to clientele. The KWRI uses a variety of methods. These include:

1. The third statewide Kansas "Governor's Conference on the Future of Water in Kansas Conference" was held on November 12-13, 2014 in Manhattan, Kansas. The conference was highly successful with 649 people attending both days of the conference. Attending the conference and giving the welcome was the Governor of Kansas, Sam Brownback. Several state and national senators and representatives were present. The Governor fully supports this conference and has expressed his concern about the issue of preserving and protecting the future viability of water in Kansas. Thirty-seven volunteer scientific and 6 invited presentations were presented in plenary and concurrent sessions. Twenty scientific posters were presented in the poster session. An undergraduate/graduate student poster award program was conducted to encourage student participation. Twelve students participated. The program agenda is included with this report.

The conference will be held again on November 18-19, 2015.

2. The website, http://www.kwo.org/Ogallala/Governors_Conference/Governors_Conference.htm is used to transfer project results and inform the public on issues and scientists on grant opportunities.

Support for the Governor

Basic Information

Title:	Support for the Governor
Project Number:	2014KS175B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	KS-001
Research Category:	Not Applicable
Focus Category:	Water Supply, Water Quality, Education
Descriptors:	None
Principal Investigators:	Dan Devlin

Publications

1. Kahl, D., A Bouc, S. Stover, D. Rogers, R. Daugherty, D. Procter. 2014. Keep the Tap Flowing: How Should Kansas Manage a Declining Water Resource? , Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF3157. 18 pg.
2. Kahl, D., B. Windholz. 2014. Agency Aughority and Responsibilities for Water in Kansas , Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF3110. 4 pg.
3. Rogers, D., J. Aguilar, I. Kisekka, P. Barnes, F. Lamm. 2014. Soil, Water and Plant Relationships , Kansas State University Agricultural Experiment Station and Cooperative Extension Service. L904 revised. 8 pg.

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HDR - *Silver*
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State Association of Kansas Watersheds - *Silver*
Tallgrass Brewing Company - *Silver*

Kansas Dairy Commission & Kansas Dairy Association - *Bronze*

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Governor's Conference on the Future of Water in Kansas

November 12-13, 2014

AD ASTRA PER ASPERA
Kansas

Hilton Garden Inn &
Conference Center
Manhattan, Kansas

AGENDA - Day 1

Wednesday, November 12, 2014

Breakfast Available at 7:30 am

Kaw Nation & Big Basin Rooms

8:00 - Registration/Tour Exhibits *(Foyer)*

9:00 - Introduction/Overview *(Continental Breakfast)*
Gary Harshberger, Chairman, Kansas Water Authority

9:05 - Welcome

9:15 - Governor Sam Brownback

9:35 - Vision for the Future of Water in Kansas
Governor's Vision Team

10:15 - *Questions & Discussion*

10:35 - *Break*

10:50 - Working With Your Available Resources
Paul Wenger, California Farm Bureau Federation President

11:20 - *Questions & Discussion*

11:30 - *Break & Tour Exhibits*

12:15 - Lunch

1:20 - Golf's Quest to Thrive With Less Water
Rhett Evans, CEO of Golf Course Superintendents Assoc. of America

1:50 - *Questions & Discussion*

2:00 - Four Revolutions and Kansas: The Challenges and the Stakes
Brigadier General Duke DeLuca Retired, U.S. Army Corps of Engineers

2:30 - *Questions & Discussion*

2:45 - *Break*

3:00 - Direct and Indirect Potable Water Reuse in Wichita Falls, Texas
Darron Leiker, City Manager, Wichita Falls, Texas

3:30 - *Questions & Discussion*

3:45 - Be the Vision
City of Hays, McCarty Dairy, Owens Corning, McPherson Refinery, Sheridan-6, Ft. Riley, Supreme Feeders

4:30 - *Questions & Discussion & Final Comments*

5:00 - Evening Social at Flint Hills Discovery Center - *(5:00 pm - 6:30 pm)*

Thank you for your participation in the Governor's Conference on the Future of Water in Kansas.

Concurrent Sessions - Day 2

Thursday, November 13, 2014

11:45 - Concurrent Session 4

A. Water Resources Data Bases *(Flint Hills, Kings & Konza Rooms)*
Moderator: Ed Martinko, Kansas Biological Survey

- USGS Earth Science Information Available NOW! *(Abstract)*
  Andy Ziegler
- Online Groundwater Resources & Tools from the KGS *(Abstract)*
  Brownie Wilson, Daniel Suchy, Dana Adkins-Heljeson, James Butler

B. Economics of Irrigation *(Alcove)*
Moderator: Susan Stover, Kansas Water Office

- Value Added to the Kansas Economy from SW Kansas Irrigation *(Abstract)*
  Josh Roe
- Getting the Most Value out of Limited Irrigation Water *(Abstract)*
  Nathan Hendricks, Jeff Peterson

C. Water Management *(Ft. Riley Room)*
Moderator: Mark Rude, GMD #3

- KS Farmers' Adaptations to Groundwater Depletion: Results from Survey
  Jeff Peterson (Abstract)
- The Effect of Water Rights on Irrigation-Based Water Use in KS *(Abstract)*
  Dietrich Earnhart

D. Water Supplies & Planning *(Discovery Center, 2nd Floor)*
Moderator: Margaret Fast, Kansas Water Office

- Tri-State Region Water Demand & Supply Availability Studies *(Abstract)*
  Michael Beezhold
- Development & Implementation of State Water Plans *(Abstract)*
  Susan Morea

12:30 - Lunch *(Kaw Nation & Big Basin Rooms)*

1:10 - Emcee - Dr. Dan Devlin, KSU

- Graduate/Undergraduate Student Poster Governor's Awards
- Reservoir Sedimentation: Challenges in Kansas
  Jerry de Noyelles, Kansas Biological Survey

2:15 - Final Comments - *Tracy Streeter, Kansas Water Office*

2:30 - Adjournment

Hosted By:

Kansas Water Office

K-STATE Research and Extension

Kansas Water Resource Institute

Concurrent Sessions - Day 2

Thursday, November 13, 2014

10:40 - Concurrent Session 3

A. Drought and Its Impact *(Flint Hills, Kings & Konza Rooms)*

Moderator: Debra Baker, Kansas Water Office

- Kansas Droughts: History, Current & Future *(Abstract)*
  Xiaomao Lin, Gerard Kluitenberg, Rob Aiken, Mary Knapp
- Drought Effects on Non-Point Source Pollution *(Abstract)*
  Richard Basore

B. New Sources of Supply *(Kaw Nation Room)*

Moderator: Chris Gnau, Kansas Water Office

- The Dakota Aquifer & Aquifers with Natural Saline Water *(Abstract)*
  Don Whittemore
- Kansas Missouri River Aqueduct Study *(Abstract)*
  Earl Lewis

C. Water Law *(Big Basin Room)*

Moderator: Rob Reschke, Kansas Water Office

- Changing the Kansas Water Appropriation Act: Promises & Pitfalls
  David Traster, Foulston Siefkin LLP; Michael Ramsey, Hope, Mills, Bolin, Collins & Ramsey

D. Water Quality III *(Alcove)*

Moderator: Jaime Gaggero, KS Dept. of Health & Environment

- Utilizing Surveys to Assess Cropping & Tillage Patterns *(Abstract)*
  Ron Graber, Dustin Fross, DeAnn Presley, Rich Schlender
- Engaging to Install BMPs in the Town of Munfor NWQI Watershed
  Stacie Minson, Brad Shank *(Abstract)*

E. Playas & Recharge II *(Ft. Riley Room)*

Moderator: Tim Boese, GMD #2

- Conservation Programs for Playa Lakes in Kansas *(Abstract)*
  Barth Crouch
- Understanding Recharge Patterns in the High Plains Aquifer, KS *(Abstract)*
  Randy Stotler, Britney S. Katz, Daniel R. Hirmas, Donald Whittemore, James Butler, Jon Smith, Greg Ludvigson (Abstract)

11:25 - ***Break/View Posters***

AGENDA - Day 2

Thursday, November 13, 2014

Breakfast Available at 7:30 am

8:00 - Registration/View Posters *(Continental Breakfast)*

8:30 - Concurrent Session 1

A. Crops & Water *(Flint Hills, Kings & Konza Rooms)*
B. Emerging Issues I *(Kaw Nation Room)*
C. High Plains Aquifer I *(Big Basin Room)*
D. Urban Water *(Alcove)*
E. Water Quality I *(Discovery Center, 2nd Floor)*

9:15 - ***Break/View Posters***

9:35 - Concurrent Session 2

A. Technology & Crops *(Flint Hills, Kings & Konza)*
B. Emerging Issues II *(Kaw Nation)*
C. High Plains Aquifer II *(Big Basin Room)*
D. Water Quality II *(Alcove)*
E. Playas & Recharge I *(Ft. Riley Room)*

10:20 - ***Break / View Posters***

10:40 - Concurrent Session 3

A. Drought & Its Impact *(Flint Hills, Kings & Konza Rooms)*
B. New Sources of Supply *(Kaw Nation)*
C. Water Law *(Big Basin)*
D. Water Quality III *(Alcove)*
E. Playas & Recharge II *(Ft. Riley Room)*

11:25 - ***Break/View Posters***

11:45 - Concurrent Session 4

A. Water Resource Data Bases *(Flint Hills, Kings & Konza Rooms)*
B. Economics of Irrigation *(Alcove)*
C. Water Management *(Ft. Riley Room)*
D. Water Supplies and Planning *(Discovery Center, 2nd Floor)*

12:30 - Lunch *(Kaw Nation & Big Basin Rooms)*

1:10 - Emcee - Dan Devlin, Kansas State University

- Graduate/Undergraduate Student Poster Governor's Awards
- Reservoir Sedimentation: Challenges in Kansas
  Jerry de Noyelles, Kansas Biological Survey

2:15 - Final Comments

Tracy Streeter, Kansas Water Office

2:30 - Adjourn

We hope you found the conference informative and enjoyable and look forward to seeing you again next year!

Concurrent Sessions - Day 2
Thursday, November 13, 2014

8:30 - Concurrent Session 1

A. Crops & Water *(Flint Hills, Kings & Konza Rooms)*
Moderator: Joe Harner, Kansas State University

- Sorghum Rain or Shine *(Abstract)*
  Sarah Sexton-Bowser, Jesse McCurry
- Protecting Water Quality Through Improved Phosphorous Management *(Abstract)*
  Nathan Nelson, Claire Baffaut, Mike Van Liew, Anomaa Senaviratne, Ammar Bhandari, John Lory & Dan Sweeney

B. Emerging Issues I *(Kaw Nation Room)*
Moderator: Jim Butler, Kansas Geological Survey

- Seismicity on the Rise in Southern Kansas *(Abstract)*
  Justin Rubinstein, William Ellsworth, Steven Walter, Andrea Llenos
- Potential Induced Seismic Activity in KS: The State's Response *(Abstract)*
  Rex Buchanan

C. High Plains Aquifer I *(Big Basin Room)*
Moderator: Marcia Schulmeister, Emporia State University

- Effects of Irrigation on Atmospheric Processes Over the Great Plains *(Abstract)*
  Dave Mechem
- Characterization of Cored Sediments from the High Plains Aquifer in Kansas *(Abstract)*
  Greg Ludvigson, Jon Smith, John Doveton, Rolfe Mandel, Laura Murphy, Anthony Layzell, Randy Stotler, Richard Sleezer

D. Urban Water *(Alcove)*
Moderator: Stacy Hutchinson, Kansas State University

- Water Usage of Selected Municipal & Rural Water Districts in KS *(Abstract)*
  Pat McCool
- Fort Riley's Net Zero Water Initiative *(Abstract)*
  Chris Otto

E. Water Quality I *(Discovery Center, 2nd Floor)*
Moderator: Bobbi Luttjohann, Kansas Water Office

- Watershed Restoration & Protection Strategy Successes *(Abstract)*
  Gary Satter, Steve Schaff
- Off-Site BMP Implementation in the Little Ark River Watershed *(Abstract)*
  Ron Graber, Trisha Moore, Josh Roe, Tom Stiles

9:15 - ***Break/View Posters***

Concurrent Sessions - Day 2
Thursday, November 13, 2014

9:35 - Concurrent Session 2

A. Technology & Crops *(Flint Hills, Kings & Konza)*
Moderator: Dan Rogers, Kansas State University

- Irrigation Innovation: Building on Advances of the Past *(Abstract)*
  Dan Rogers, Jonathan Aguilar, Isaya Kisekka,

B. Emerging Issues II *(Kaw Nation)*
Moderator: Andy Ziegler, U.S. Geological Survey

- USGS Mapping Science of National Hydrography Dataset in KS Watersheds
  Ingrid Landgraf, Jenny Lanning-Rush (Abstract)
- By the Numbers: An Overview of Statistics & Data Underlying Kansas Water Discussion *(Abstract)*
  Jude Kastens, Jerry DeNoyelles Ed Martinko, Don Huggins

C. High Plains Aquifer II *(Big Basin Room)*
Moderator: Lane Letourneau, Kansas Department of Agriculture

- Sheridan County #6 LEMA Panel
  Kate Durham, Mitch Baalman, Bill Golden

D. Water Quality II *(Alcove)*
Moderator: Andrew Swindle, Wichita State University

- Simulation of Groundwater Flow & Chloride Transport in the Equus Beds Aquifer *(Abstract)*
  Brian Klager, Brian Kelly
- Advancing the Use of Lower Quality Sources of Water in Kansas – Bureau of Reclamation's Perspective *(Abstract)*
  Thomas Michalewicz, P.E.

E. Playas & Recharge I *(Ft. Riley Room)*
Moderator: Stacie Minson, Kansas State University

- Types of Recharge Incorporated in Groundwater Models in the High Plains Aquifer *(Abstract)*
  Don Whittemore, Gaisheng Liu, Brownie Wilson, James Butler
- Progressive Loss of Kansas Playas - a Source of Biodiversity & Potential Groundwater Recharge *(Abstract)*
  Bill Johnson, Mark Bowen

10:20 - ***Break/View Posters***

Governor’s Conference on the Future of Water in Kansas
Poster Presenters

Faculty/Staff/Professional

1. **Groundwater-Level & Storage-Volume Changes in Equus Beds Aquifer near Wichita, Predevelopment to 2014** *(abstract)*
   Cristi Hansen, Kansas Water Science Center, U.S. Geological Survey
   Joshua Whisnant, Kansas Water Science Center, U.S. Geological Survey

2. **Why Should I Use Irrigation Scheduling?** *(abstract)*
   Freddie Lamm, Northwest Research-Extension Center, Kansas State University
   Dan Rogers, Biological and Agricultural Engineering Kansas State University

3. **Ogallala Aquifer Declines at the NWREC and Monitoring the Declines Going Forward** *(abstract)*
   Freddie Lamm, Northwest Research-Extension Center, Kansas State University
   James Butler, Kansas Geological Survey, University of Kansas
   Dan Rogers, Biological and Agricultural Engineering Kansas State University

4. **Water Use of Corn: Historical and Current Perspectives** *(abstract)*
   Freddie Lamm, Northwest Research-Extension Center, Kansas State University

5. **Assessment of Residual Soil Water on Corn Fields of Western Kansas** *(abstract)*
   Freddie Lamm, Northwest Research-Extension Center, Kansas State University
   Dan Rogers, Biological and Agricultural Engineering Kansas State University
   Alan Schlegel, Research and Extension, Kansas State University
   Norm Klocke, Research and Extension, Kansas State University (retired)
   Loyd Stone, Department of Agronomy, Kansas State University
   Kent Shaw, SWREC, Kansas State University

6. **The USGS Mapping Science of the National Hydrography Dataset in Kansas Watersheds** *(abstract)*
   Jenny Lanning-Rush, Kansas Water Science Center, U.S. Geological Survey
   Ingrid Landgraf, U.S. Geological Survey

7. **Terrain and Soil Restrictions of Crop Production in Southeast Kansas** *(abstract)*
   Gretchen Sassenrath, Agronomy/SEARC, Kansas State University
   Tom Mueller, John Deere, Inc.

8. **Little Arkansas River and Equus Beds Aquifer Water Quality Before and Concurrent with Large-Scale Artificial Recharge, South-Central Kansas, 1995-2012** *(abstract)*
   Daniel Tappa, U.S. Geological Survey

Student Posters

1. **Optimal Best Management Practices (BMPs) for Poultry Litter Applications in South East Kansas** *(abstract)*
   Ammar Bhandari, Agronomy, Kansas State University
   Nathan Nelson, Agronomy, Kansas State University
   Daniel Sweeney, Agronomy, Kansas State University
   Gary Pierzynski, Agronomy, Kansas State University

2. **Tracking Gully Development in Two Kansas Landscapes** *(abstract)*
   Katie Burke, Environmental Design and Planning, College of Architecture, Kansas State University

3. **The Republican River Compact: Contested Space and the Politics of Water** *(abstract)*
   Jean Eichhorst, Geography, University of Kansas

4. **Playa Wetland Distribution and Geomorphology in Western Kansas** *(abstract)*
   Melissa Goldade, Geography, University of Kansas
   William Johnson, Geography, University of Kansas

5. **No-Till is not Enough: The Effect of Soil Moisture on Ephemeral Gully Erosion** *(abstract)*
   Vladimir Karimov, Biological and Agricultural Engineering, Kansas State University
   Aleksey Sheshukov, Biological and Agricultural Engineering, Kansas State University

6. **An Assessment of the Erodibility of Holocene Alluvium Comprising Streambanks in Northeastern Kansas** *(abstract)*
   Tony Layzell, Kansas Geological Survey, University of Kansas
   Rolfe Mandel, Kansas Geological Survey, University of Kansas

7. **Monitoring Constructed Wetlands for Volume, Sediment & Nutrient Reduction from Agricultural Stormwater Runoff** *(abstract)*
   LlynnAnn Luellen, Civil, Environmental and Architectural Engineering, University of Kansas
   Bryan Young, Civil, Environmental and Architectural Engineering, University of Kansas
   Edward Peltier, Civil, Environmental and Architectural Engineering, University of Kansas

8. **Modeling Field-Level Irrigation Demand with Changing Weather and Crop Choices** *(abstract)*
   Babak Mardan Doost, Civil, Environmental & Architectural Engineering, University of Kansas
   Belinda Sturm, Civil, Environmental & Architectural Engineering, University of Kansas
   Johannes Feddema, Geography, University of Kansas
   Nathaniel Brunsell, Geography, University of Kansas

9. **Dynamic Curve Number (CN) Development Using Normalized Difference Vegetation Index (NDVI)** *(abstract)*
   Muluken Muche, Biological and Agricultural Engineering, Kansas State University

10. **Kansas Variability and Trends in Extreme Precipitation Indices** *(abstract)*
    Vahid Rahmani, Biological and Agricultural Engineering, Kansas State University
    Stacy Hutchinson, Biological and Agricultural Engineering, Kansas State University
    John Harrington, Jr., Geography, Kansas State University

11. **Defining Perceptions of Watershed Management in a Great Plains Watershed** *(abstract)*
    Diana Restrepo, Geography, University of Kansas

12. **Trace Metal Analysis of Little Arkansas River as Urbanization Increases to Wichita, Kansas** *(abstract)*
    Jacob Sinclair, Geology, Wichita State University
    William Parcell, Geology, Wichita State University

Special Thanks to the Governor's Award Judges:
Daniel Clement, Burns & McDonnell**;** Julie Coleman, Kansas Dept of Health & Environment; Amber Campbell, Kansas State University; Don Huggins, Kansas Biological Survey, University of Kansas; Diane Knowles, Kansas Water Office; Shane Lyle, URS Corporation; Andrew Miller, Chemistry, Emporia State University; Erika Stanley, Kansas Water Office.
Judging Coordinator: Susan Stover, Kansas Water Office

Appreciation to the Student Cash Award Sponsor: Westar Energy

The Governor's Conference on the Future of Water in Kansas

Sponsored By:

Black & Veatch – *Reception*
Burns & McDonnell - *Reception*
Great Lakes Dredge & Dock - *Reception*

Kansas Grain Sorghum Commission/United Sorghum Checkoff Program - *Platinum*
Kansas Rural Water Association - *Platinum*
Syngenta - *Platinum*
Westar Energy - *Platinum & Student Awards*

BTI - *Gold*
CDM Smith - *Gold*
Conestoga - *Gold*
Dow Agrosciences - *Gold*
Dragon-Line - *Gold*
First Water Ag - *Gold*
Kansas Biological Survey - *Gold*
Kansas Department of Agriculture - *Gold*
Kansas Department of Wildlife, Parks & Tourism - *Gold*
Kansas Farm Bureau - *Gold*
Kansas Forest Service - *Gold*
Kansas Geological Survey - *Gold*
Kansas Groundwater Management Districts - *Gold*
Select Energy - *Gold*
Servi-Tech EPS, LLC - *Gold*
Stantec - *Gold*

Brown & Caldwell - *Silver*
From the Land of Kansas - *Silver*
HDR - *Silver*
Kansas Bankers Association - *Silver*
Kansas Municipal Utilities - *Silver*
Professional Engineering Consultants - *Silver*
Smoky Hill Vineyards & Winery - *Silver*
State Association of Kansas Watersheds - *Silver*
Tallgrass Brewing Company - *Silver*

Kansas Dairy Commission & Kansas Dairy Association - *Bronze*

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	0	0	0	1
Masters	4	0	0	0	4
Ph.D.	1	0	0	0	1
Post-Doc.	1	0	0	0	1
Total	7	0	0	0	7

Notable Awards and Achievements